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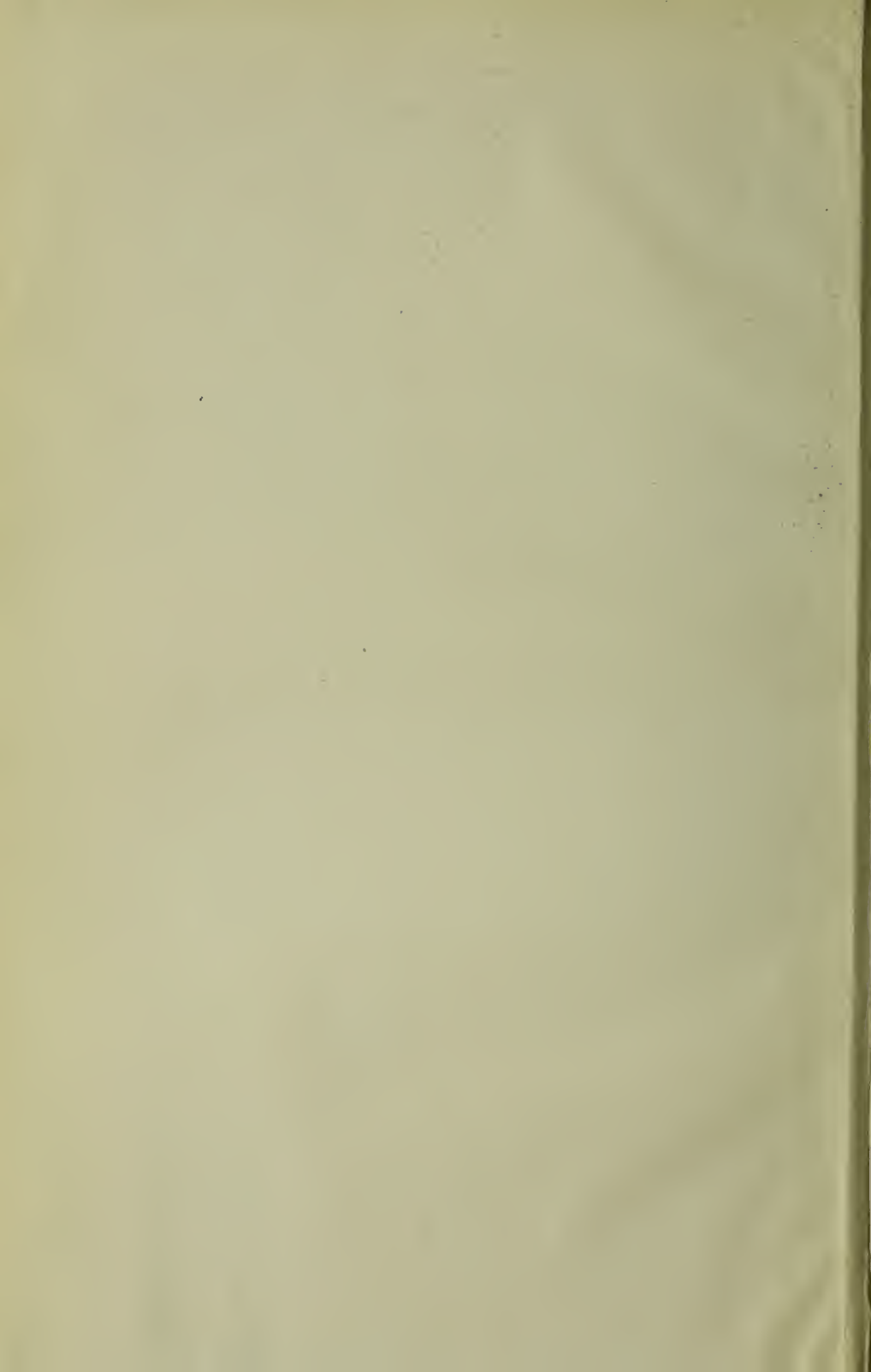
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GLASGOW HOSPITAL REPORTS

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MDCCCXCVIII.

# GLASGOW HOSPITAL REPORTS

*EDITED FOR THE COMMITTEE*

BY

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VOL. I.

*WITH 65 ILLUSTRATIONS*

GLASGOW

JAMES MACLEHOSE AND SONS

Publishers to the University

1898

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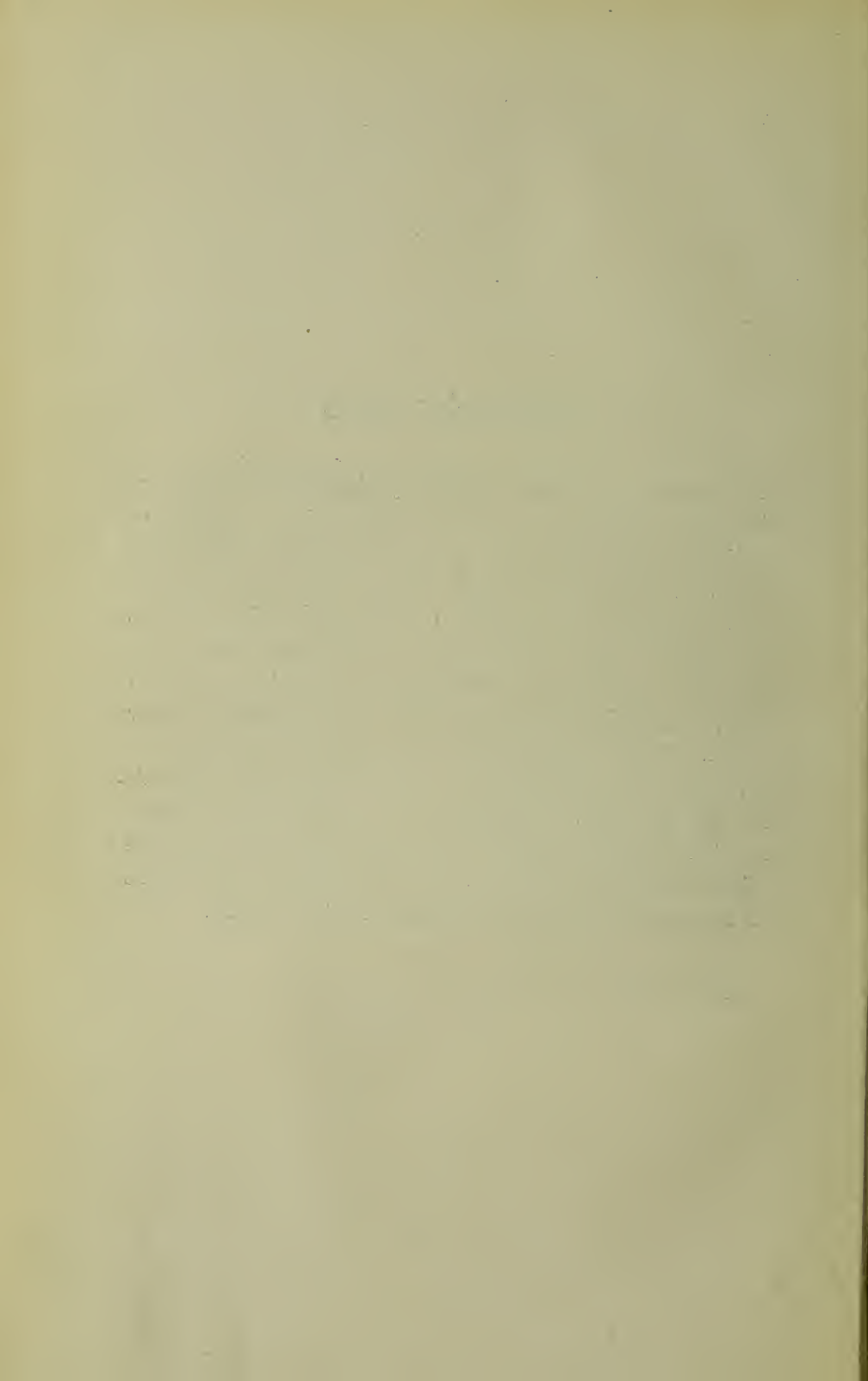
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## PREFATORY NOTE

IN response to a circular signed by the Superintendents of the Royal, Western, and Victoria Infirmaries, a meeting of medical men, mostly members of the staffs of the various Hospitals, was held in May, 1896, to consider a proposal to establish an annual volume of Glasgow Hospital Reports. The proposal was unanimously approved, and at a later date, after the necessary preliminary investigations had been made, a Committee of Management was appointed to carry it out. This Committee and the Editors had hoped to have the first volume in the hands of Subscribers towards the end of 1897. Circumstances, however, have delayed the issue till the present time, but, with the experience gained, the Editors believe that the Subscribers may count on the annual issue of the Glasgow Hospital Reports.

*December, 1898.*





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## INTRACRANIAL TUMOURS.

By T. M'CALL ANDERSON, M.D.,

Professor of Clinical Medicine in the University of Glasgow;  
Physician to the Western Infirmary.

THE symptoms of intracranial tumours vary much in character and in degree for many reasons, such as their nature, size, rapidity of growth, and, above all, their seat. In many cases they give rise to no symptoms at all, being discovered only on post-mortem examination, while, in others, these are of such an indeterminate character as to render the diagnosis a source of the greatest difficulty. But, though differing exceedingly in their clinical characters, there are yet certain outstanding symptoms which, when present, leave no reasonable doubt as to their presence.

The most frequent and most prominent of these is *headache*, which is usually persistent, but with paroxysmal exacerbations which may be truly agonising in character. It is usually aggravated by violent exertion or excitement, often by exposure to light or sound. It may affect the whole or any part of the head, is often one-sided (hemicrania), and usually remains in the same locality throughout; but the seat of the pain is no necessary criterion of the situation of the tumour, although, when markedly concentrated in the occipital region, it excites a strong suspicion of cerebellar disease. Gentle tapping of the skull, in the case of superficial tumours, generally produces tenderness over the seat of the disease, not elsewhere, and is thus sometimes an aid to localisation.

*Vertigo* is seldom altogether absent throughout, and is frequently the first symptom. It is generally most troublesome during the exacerbations of pain and on assuming the erect

posture, while it is often absent when the patient is at rest, and, where it is of ocular origin, may be relieved by shutting the eyes. As Reynolds has remarked, the patient does not generally complain of surrounding objects rotating, but feels as if rolling over, or swimming along in space. Vertigo is specially severe and frequent in cases of disease of the cerebellum and middle cerebellar peduncle.

*Sympathetic Vomiting* is often a prominent feature, particularly in the early stages, and when the headache is severe. It is generally unaccompanied by nausea or other symptoms of stomach disorder, has no special reference, as a rule, to the taking of food, and is frequently relieved by maintaining the recumbent posture. It is usually associated with constipation.

*Optic Neuritis* is one of the most constant accompaniments of intracranial tumours. Statistics as to its frequency are not entirely in harmony, but Gowers' statement, that neuritis is present in at least four-fifths of the cases, may be regarded as very near the mark. Hence it is evident that its presence is of great significance in the diagnosis of intracranial tumour. It may be one of the earliest symptoms, and may first arouse suspicion of organic intracranial disease; but it should always be remembered that it may not appear until late in the course of the development of the tumour. In a case of suspected tumour, therefore, the eyes should be examined from time to time and the condition of the discs carefully watched. Another important fact to bear in mind is that there may be considerable optic neuritis in both eyes without there being any lowering of the visual acuity, or at least such as is appreciable to the patient. Hence, in all suspicious cases, the eyes should be carefully examined as a matter of routine, even although the patient assures us that his vision is good. The optic neuritis in these cases is nearly always bilateral, although a very few cases have been reported where, with unilateral neuritis, an intracranial tumour was afterwards found.

It has been attempted to draw a distinction between cases where the changes in the optic discs were due to mechanical compression caused by an accumulation of fluid in the sheath, the so-called "choked disc," and those in which the inflammatory changes had travelled down the optic nerve to the disc,



“descending neuritis.” It is now, however, generally admitted that this distinction cannot be made clinically, nor is it of any diagnostic importance.

The optic neuritis varies greatly in intensity in different cases, and in the same case will present different degrees of intensity at different times. In a case of optic neuritis of considerable intensity, such as we mostly meet with at some stage of an intracranial tumour, the chief appearances are as follows :

The disc is greyish-red in colour, often assuming a peculiar blue-grey tint. It is swollen, but the degree of swelling varies considerably. It can be roughly measured by observing the difference in the strength of lens which is necessary to focus accurately the surface of the swollen disc and the surrounding retina, and allowing one millimetre for every three dioptries of difference. The edges of the disc are obscured, and cannot be seen. The vessels are seen to curve over the swollen disc, and may be here and there completely concealed by the swollen nerve tissue. The arteries are frequently narrowed and the veins distended and tortuous, a condition which may persist for a considerable distance from the disc. Haemorrhages are frequent, and are commonly situated on the edge rather than at the surface of the swollen disc. If the neuritis is very intense, the swollen disc may occupy an area very much larger than normal, and hence the nutrition of the surrounding retina for a considerable distance may be greatly disturbed, as evidenced frequently by the presence of haemorrhages and white spots. When the neuritis subsides and the disc shrinks to its normal dimensions, the presence of these white spots, especially if near the macular region, may puzzle the inexperienced ophthalmoscopist from their resemblance in character and position to the spots of albuminuric retinitis.

The rapidity with which the neuritis is developed varies very considerably. It may reach a high degree of intensity in the course of two or three weeks, or even, after several months, may only be very moderate. Rapid development, as a rule, is associated with great intensity of the neuritis. The first sign of the subsidence of the neuritis is a diminution of vascularity, a still further contraction of the arteries, and later of the veins

also. The edges of the disc become gradually visible. The disc resumes a normal appearance only when the neuritis has been slight: when it has been of considerable intensity, the disc finally appears abnormally pale in a condition of consecutive or post-papillitic atrophy. That the atrophy has followed an acute neuritis is frequently evidenced by the filled-in appearance of the disc, by the narrowness of the vessels, often accompanied by white lines along their walls, by the edges being somewhat irregular, and the choroid and retina in the neighbourhood showing signs of previous disturbance, either by alterations in the pigment or by the presence of white spots.

Although the discovery of double optic neuritis is strongly in favour of the presence of an intracranial tumour when the other symptoms point distinctly in that direction, yet, when the other symptoms are obscure, too much importance must not be attached to its presence. It occurs in many other conditions, as in cerebral meningitis, cerebral abscess, syphilis, lead poisoning, anaemia, and in disturbances of nutrition of very various kinds.

While, then, the presence of double optic neuritis is a valuable confirmatory sign of the presence of an intracranial growth, it affords us no information as to the position, size, or character of the tumour. It is met with in tumours occupying all positions within the cranium; it is seen with tumours not as large as a walnut, and is sometimes absent although they are very large; and it occurs with every variety of intracranial growth.

Finally, it should be borne in mind that an intracranial growth exercising pressure on the chiasma, or on the optic nerves in front of the chiasma, may cause a simple atrophy without any antecedent neuritis. (Hinshelwood.)

*Paralytic phenomena* are common, but generally not widespread, although hemiplegia is far from rare. In that case the paralysis usually sets in slowly, implicates a limited area at first (*e.g.* the face or hand), and gradually extends, while increasing in intensity. This is very suspicious, and the suspicion is almost converted into a certainty if accompanied by double optic neuritis. Much more frequently there is paralysis.



of one or more of the cranial nerves, which is almost always peripheral (the paralysed muscles not responding to Faradisation), because the tumour often springs from the skull or the membranes, implicating the brain secondarily, or it may spread from the brain to the nerves emerging from it. Consequently, when hemiplegia and paralysis of a cerebral nerve occur together, it is generally observed that, while the former is on the opposite side from, the latter is on the same side as, the lesion (crossed paralysis), unless there is more than one tumour.

*Convulsive seizures* are frequent, and may be the first and only symptom for a time. In that case we may suspect the possible presence of a tumour, if we are able to exclude the other causes of convulsions. If to these symptoms headache and vomiting are added, and, above all, double optic neuritis, there can be very little doubt. Convulsions are most common when the cerebral cortex is involved. The duration of the aura and of the fit is apt to be more prolonged than when due to other conditions, and the latter is apt to be partial, being often limited to one side, or implicating one limb or a hand (Jacksonian epilepsy). In some cases the convulsive seizures may have a local beginning, and, gradually spreading, become general. This local commencement is peculiarly significant, and points to the seat of tumour. A local sensory aura preceding the convulsive seizure has the same localising significance as the motor commencement, pointing to the locality in which the chief irritation exists. In some cases convulsive seizures are replaced by tonic contractions of the muscles or clonic spasms.

In children there is occasionally an alteration in the shape of the head, but rarely in adults.

*Mental Disturbances.* Amongst the terminal symptoms of most forms of intracranial tumour are stupor and coma. Sometimes, however, at a comparatively early stage in the development of the disease, psychical symptoms appear, the most frequent being general blunting of the mental powers, weakening of the memory, with loss of emotional control.

*Prognosis and Treatment.* In arriving at an opinion as to the probable upshot of a case of intracranial tumour, we must of course take into consideration the character and severity of the symptoms, and, up to a certain point, the duration of the disease

when the patient comes under observation ; for, of course, the longer it has been present, the greater is the likelihood of secondary changes having been induced in the surrounding brain substance. But, after all, the main points to be determined are (1) the situation of the tumour, and (2) its nature.

As regards the former, it stands to reason that the prognosis is more grave when the symptoms point to the involvement of important or vital parts. But if the symptoms enable us accurately to localise the tumour, and to satisfy ourselves that it is accessible, there is a reasonable hope that a cure may result from operative interference,—an illustration of which is given further on (Case 7).

As regards the nature of the tumour, we can only hope for a cure if it is syphilitic or tubercular, and, in rare cases, if it is aneurismal. The space at my disposal will not permit me to say anything with regard to the diagnosis and treatment of *syphilitic deposits*. A *tubercular tumour* may be suspected if we take into account the following circumstances. It is most commonly met with in children between the third and seventh years, and in young adults. There is often a tubercular family history, and other organs and tissues may be involved: *e.g.* in the adult we are almost certain to find a deposit of tubercle in the lungs, although it need not necessarily give rise to symptoms during life. The symptoms of tumour, too, are often associated with those of tubercular meningitis. There is usually some elevation of temperature, although pyrexia is generally a less pronounced feature when the brain is involved than when other organs are attacked. We can thus sometimes be pretty sure of our diagnosis, and we are occasionally successful in causing the symptoms to disappear by pushing cod liver oil, phosphorus, and other anti-strumuous measures, while palliating any prominent symptoms which may be present, *e.g.* headache, vomiting, pyrexia (Case 3). *Aneurism* is not always so large as to give rise to the typical symptoms of tumour, and we then have great difficulty in recognising its nature. We endeavour to exclude other kinds of tumour, while we ascertain whether any of the known causes of aneurism are present—syphilis, valvular disease, injury, etc. We look for symptoms of tumour in the neighbourhood of vessels specially liable to be involved: *e.g.* the

left middle cerebral artery or the large vessels at the base of the brain. Headache is a very constant symptom, is often intense and accompanied by throbbing in the head, while unilateral paralysis of cranial nerves may be expected to appear early in the attack. Exceptionally a murmur may be heard by the patient, or even by the physician on auscultation. If we suspect aneurism, it must be treated by means of absolute rest of body and mind, iodide of potassium in large doses, and the other remedies applicable to aneurism in general, while cases of cure have been recorded as the result of ligature of the common carotid artery.

If the tumour is beyond the reach of operative interference, and is neither syphilitic, tubercular, nor aneurismal, we most generally confine ourselves to palliative treatment in the hope, which is occasionally realised, that the symptoms may subside, and a certain measure of health be restored.

The cases which follow illustrate some of the remarks which have been made.

- Case 1.* A case of supposed disease of the Pons Varolii.
- Case 2.* Tumour of the Medulla Oblongata.
- Case 3.* Case of Cerebellar Disease, probably Tubercular.
- Case 4.* Disease of the Middle Lobe of the Cerebellum.
- Case 5.* Malignant Tumour at the base of the brain, with  
Secondary Nodules in the liver.
- Case 6.* Tubercular Tumour of the Cerebellum with Meningitis and Tubercular Deposits in other organs.
- Case 7.* Cerebral Tumour removed by operation.

### CASE 1.

#### A CASE OF SUPPOSED DISEASE OF THE PONS VAROLII.

A female, aged twenty-three, a spinner by occupation, was admitted into the Western Infirmary on 7th August, 1875, with the following history.

Her father died at the age of forty-six, of typhus fever; her mother at forty-eight, of heart disease. She has one sister and

two brothers alive and well, and another brother who has been ill for some years, although she cannot tell the nature of his complaint.

"Prior to the commencement of her present illness she seems always to have enjoyed good health, although her bowels have been habitually costive, and her menstruation, which made its appearance at the age of seventeen years and a half, never very regular—six or eight weeks sometimes intervening between the periods. About two years ago she began to complain of headache which was limited to the left side of the head, and which has continued ever since. The pain is spoken of as being of a 'beating character.' It is more or less constantly present, but becomes aggravated at times, especially in the forenoon. It is particularly severe in the left supraorbital region. Within the last six weeks the headache has been accompanied by giddiness, especially when the pain is severe; so that her gait at these times is unsteady, and she feels as if she is going to fall.

"About seven weeks prior to admission she began to complain of a 'prickling' soreness along the left margin of the tongue, which was increased by eating, and she had great difficulty in pronouncing words. There was also impairment of the sense of taste to a certain extent; for although she could distinguish between sweet things and bitter, etc., food tasted differently from what it had previously done, though in what the difference consisted she could not explain. In a day or two after the tongue became sore, she says she felt a few hard lumps along its left edge, each being about the size of a pea, and very painful to the touch. They disappeared in about three days. As the symptoms referable to the tongue began to abate, the vision of the left eye became somewhat impaired, and she often fancied that she saw things on the floor which were not present. At first the eyeball was bloodshot to a marked degree, but in a few days the congestion passed off and did not return. At the same time as the eye became affected—*i.e.* five weeks before admission—the left cheek felt stiff, swollen, and painful, and gradually became paralysed; she observed that she could not close the left eye, and that her mouth was drawn to the right side. The sense of hearing was not affected.



About two weeks after this she experienced a feeling of 'numbness and coldness' in the left shoulder, which generally spread down the limb, and was followed by weakness, so that she was unable to hold anything in the hand. Immediately afterwards the left leg became similarly affected, and subsequently the right also. The paralysis of the lower extremities, too, was only partial, as she could walk, though her gait was unsteady, and there was a tendency to dragging of the feet. Finally, five days prior to admission, whilst resting her head upon her right hand, a sharp pain was suddenly experienced in her right shoulder, and spread down the arm to the fingers, causing it to drop on the table. The pain passed off in about a minute, but was followed by a feeling of coldness and numbness, and by partial loss of power. She has also had 'prickling' pains in the arm at intervals, but no involuntary twitchings. About four months before she was admitted she received a violent blow upon the head over the left eyebrow, which caused her to have a strange sensation in the left side of the upper part of the head for eight or nine days, but from this she recovered perfectly."

On admission her general health was good; the affection of the tongue and left eye had disappeared, but the paralysis of the left side of the face and the semi-paralytic condition of the arms and legs continued. The sensation, as to touch and temperature, was unimpaired; but in the left leg the sense of pain was below par. The tongue was protruded in the middle line, but the uvula was distinctly carried to the right side. The left cheek was slightly swollen and without expression, the mouth was carried to the right side in laughing, and she was quite unable to whistle or to close her left eye.

Here, then, is a strange and unusual array of threatening and apparently unassociated symptoms, and in connection with them we have to consider first, the seat of the disease, and, secondly, the nature of the disease.

1. *The Seat of the Disease.* A prominent feature in the case was paralysis of the left side of the face; indeed, the seventh nerve was completely paralysed, and, as we so often see in cases of this kind, the paralysed muscles did not respond to Faradisation. Now, paralysis of the seventh nerve may be

due to either central or peripheral causes, and in the latter case, if not traumatic, it is generally due either to exposure to cold or to disease of the middle ear. The following case is a good illustration, although a rare one, of paralysis of the portio dura nerve in connection with disease of the middle ear.

A woman, aged thirty-seven, of average general health, consulted me on the 8th April, 1863. She informed me that about a month previously (10th March) she went to witness the review on Glasgow Green, in honour of the marriage of the Prince of Wales. She was stooping down to raise her child from the ground, when a cannon was fired about an hundred yards (she said) from her, the right ear being directed towards it. Immediately deafness supervened on that side, and she was sensible of tinnitus, which she described as being like "the rush of distant water," and which still continued when I saw her. About two weeks after the accident she observed that when she spoke her mouth was drawn to the left side and she was unable to close the right eye.

On examination, I found that the paralysis of the right side of the face was complete, and that the tongue, when protruded, was drawn apparently towards the right side. The hearing on the left side was perfect; on the right the watch was inaudible, either when placed on the temple or pressed against the ear. On inspecting the right ear the meatus was quite natural, but the drum was slightly milky-looking, and rather more concave than natural, although the triangular bright spot passing downwards and forwards from the point of the handle of the malleus was well defined. On the posterior segment of the drum, parallel to the handle of the malleus, commencing on a level with the middle of it and extending a little way below it, a white ragged line was observed which had all the appearance of a cicatrix. The Eustachian tube was nearly impervious. The patient had experienced no pain in the ear at all, nor was the system apparently affected in any way. The prognosis noted down at the time was favourable as regards the paralysis; as regards the deafness, slight improvement to be expected; as regards complete recovery of the hearing, unfavourable; and, as regards the tinnitus, doubtful. She was ordered to apply two leeches to the orifice of the meatus, and to take three

calomel-and-opium pills daily, each pill containing two grains of calomel and one third of a grain of opium.

On the 13th April the following was the report: Leeches bled well; gums unaffected; paralysis as before; watch heard on pressing it firmly against the ear, and distinctly audible when placed on the temple, though not so much so as on the left. The following ointment was now rubbed on the right cheek in front of the ear, morning and evening: Croton oil, half a drachm; antimonial ointment, one ounce.

On the 20th, the watch was still more distinctly audible on the temple, and was heard at the distance of one inch from the ear; the paralysis was slightly improved, especially as regards the closing of the eye. The ointment was omitted. A fly blister, two and a half inches square, was applied immediately in front of the ear.

On the 29th, the following report was made: Watch nearly as audible on the right as on the left temple, and heard at a distance of three inches from the ear; paralysis decidedly less in every respect; tinnitus not quite so loud; drum less opaque. Gums never decidedly affected, though the right cheek was indented by the teeth and slightly ulcerated. The blister was repeated, and a tablespoonful of the following mixture was taken twice daily: iodide of potassium, half an ounce, infusion of quassia, twelve ounces. The pills were discontinued.

On the 6th May, a month from the date of her first visit, the paralysis was almost gone; the watch was heard six inches from the ear; the tinnitus remained as on the 29th April; and the drum, though less opaque than at the first visit, was still muddy.

She was recommended to continue the iodide of potassium mixture, and to return, which, however, she never did, so that I am unfortunately unacquainted with the ultimate issue of the case. I had intended to have endeavoured to overcome the obstruction of the Eustachian tube by means of the catheter, with the hope of thereby improving still further the hearing power and of diminishing the tinnitus.

This case is worthy of being recorded, because, as far as my experience and reading go, I have never met with a similar one. That cases of deafness suddenly produced by loud noises are of frequent occurrence no one can deny, and we are all

conversant with the supervention of paralysis in consequence of inflammation of the tympanic cavity; but I know of no other case in which there was a combination of these two sets of symptoms. It will be useful, therefore, to inquire into the nature of the case. There can be no doubt that the shock produced by the report of the cannon caused an immediate injury to the ear, and one can have little hesitation, judging from what we know to be the usual cause of deafness from concussion, in affirming that some injury was done to the nervous apparatus in the internal ear; but, unfortunately, sufficient opportunity has not yet been afforded for ascertaining the exact form of injury which is produced in these cases. It is to be hoped, however, that, as the diseases of the ear come to be more carefully studied by the profession, this point may be satisfactorily elucidated.

But in addition to the injury inflicted upon the internal ear, I have no doubt that a rupture of the drum took place at the moment of the discharge of the gun, for this is by no means a rare result of loud noises, and, besides, it would satisfactorily account for the very distinct cicatrix which was noted at the first visit of the patient on the posterior segment of the drum, and likewise for the subsequent symptoms. I have thus endeavoured to account for the sudden tinnitus and loss of hearing, and for the cicatricial appearance of the drum; but how can the paralysis be accounted for? The explanation I give of it is this: The injury done to the drum and other structures in the middle ear excited a chronic inflammation of the mucous membrane of the cavity of the tympanum, unaccompanied, as is so often the case, by any appreciable pain. Hence the opaque appearance of the drum when the patient first came under observation, and the partial obstruction of the tympanic orifice of the Eustachian tube. As this inflammatory condition proceeded it extended to the aqueduct of Fallopius, as we observe in many uncomplicated cases of tympanitis; and the portio dura nerve in this canal becoming implicated, paralysis of the right side of the face supervened.

The object of the treatment was to allay the inflammatory condition, and the result was as satisfactory as could have been expected under the circumstances.



In the case under consideration, there is reason to believe that the paralysis of the portio dura was not peripheral, but due to central disease, first, on account of the absence of the usual causes of peripheral paralysis; and, secondly, on account of the accompanying paralysis of the limbs. Now, cerebral disease associated with well marked paralysis of the seventh nerve is usually seated in the pons varolii. The following case, reported by Dr. James Russell,<sup>1</sup> and which was marked by many of the symptoms present in our patient, illustrates this point:

A lady, aged forty-two, whom Dr. Russell saw on October 22nd, 1868, along with Mr. Hickenbotham, became (in May, 1867) suddenly insensible, and had convulsive movements of the left side. The left side of the face also was "drawn." She perfectly regained consciousness, but remained with imperfect paralysis of the left limbs and of all the muscles supplied by the right portio dura, the tongue deviating to the left side. Three or four days after her seizure the right eye became much congested and swollen, and continued so for three days, there being neither prominence of the globe nor lachrymation, nor apparently any alteration of the pupil. These attacks of congestion of the right eye frequently recurred, and once the left eye was similarly affected. In the first week of December Mr. Hickenbotham was suddenly summoned to her, and found her speechless, but quite conscious, earnestly endeavouring to form words. A few hours afterwards she was quite unconscious, and died within twenty-four hours of her seizure.

At the autopsy a narrow, irregular slit was found to exist at the upper part of the right side of the pons, about one-third of an inch in length. Close to it, possibly communicating with it, were two small passages, about half a line wide and twice that length, burrowing across the septum of the pons. There was a faint yellow staining in the surrounding tissue. The tissue of the pons was firm, and there did not appear any wasting of the right half. The medulla oblongata and the crura were healthy. The root of the seventh nerve was not lessened in bulk. The right cerebral ventricle contained about an ounce and a half of loose fresh coagulum. The outer half of the corpus striatum and thalamus and the central tissue

<sup>1</sup> *British Medical Journal*, October 24th and December 12th, 1868.

enclosing the ventricle on the other side were broken down, converting the ventricle into a large irregular cavity. The septum lucidum was preserved, and the left ventricle contained only some clear colourless fluid. The arteries at the base of the brain were unusually stiff and patulous; both the trunks and the primary branches were spotted with thickened patches, very visible in their interior aspect. In all other respects the brain and its membranes were healthy.

In this instance the symptoms present in my patient were observed, with the exception of the affection of the tongue and of the paralysis of the extremities of *both* sides.<sup>1</sup> How, then, can we account for the affection of the tongue? Let me first of all mention a case of facial paralysis, accompanied by implication of the tongue, reported by Dr. Bazire.<sup>2</sup>

W. M., aged forty-eight, an instrument manufacturer, who works habitually in a cold, damp place, applied as an out-patient at the hospital on March 25th, 1867. He stated that seventeen days previously he had noticed that the left side of his face was completely paralysed, and added that for two or three days before this he had a sensation, confined to the left side of his tongue, as if the organ had been scalded. Since the paralysis had set in he had constantly had a metallic taste on that side. The common tactile sensibility of the parts was not affected. He had been hard of hearing of both ears for many years, but since his face had been paralysed he had been struck with the fact that he could hear better with his left ear than with the right, and decidedly better than before. When he was first seen by Dr. Bazire he presented the well-known appearance of facial palsy—the smooth forehead, and blank aspect of one half of the face; inability to close the eye on the affected side, to whistle, to frown on that side, etc. The left half of the tongue and of the oral cavity were not drier than the right, but the patient distinctly stated that he had a metallic taste in the left half of his tongue. His uvula was pendulous, but in a straight line, not inclined to either side; the left half of the velum palati was apparently depressed and lower than the right half. Hearing was decidedly better on

<sup>1</sup> Only one side of the body was paralysed in Mr. Hickenbotham's case.

<sup>2</sup> *British Medical Journal*, September 21st, 1867, p. 249.

the left (that of the paralysis) than on the right side. The perversion of taste present in this case, as well as in my own, is due, according to Claude Bernard, either to "a modification of the circulation of the part, or to deficient erection of the papillae of the tongue preventing proper contact between them and the sapid substances."<sup>1</sup> This is the result of paralysis of the chorda tympani nerve—a branch of the facial, which joins the lingual branch of the fifth nerve—as is proved by the slightly metallic taste first noticed by Duchenne to result from Faradisation of the membrane of the tympanum, which at the same time stimulates the chorda tympani.

When the disease is seated in the upper half of the lateral region of the pons, the facial paralysis and the paralysis of the limbs are situated on the opposite side of the body from the lesion; but, when the lower half is involved, the paralysis of the face is on the same, that of the limbs on the opposite side from the lesion; for, in that case the facial is implicated after its decussation, while the motor channels for the limbs decussate below the pons.

But how can we account for the paralysis of the limbs on both sides of the body? In this way, no doubt. The paralysis of the left side of the face, the right arm, and the right leg, may be due to implication of the left side of the pons, while the extension of the disease beyond the middle line would account for the paralysis on the left side of the body.

2. *The Nature of the Disease.* I think we may reasonably conclude that the symptoms are due either to haemorrhage, softening, or tumour. In all probability they are not due to *haemorrhage*. The history is quite different from that which we would expect in such cases: *e.g.* pain of the head of two years' duration is never observed. Again, this condition is most frequently noticed in persons who are getting up in years, and in whom there is more or less evidence of degeneration of the coats of the superficial vessels—pointing to the probability of a similar degeneration of the cerebral vessels, such as usually precedes rupture—and often there is evidence of cirrhotic disease of the kidneys; while my patient is young, the superficial vessels are natural, and the kidneys healthy.

<sup>1</sup> See Dr. Bazire's paper before-mentioned.

Softening of the brain is usually dependent upon obstruction of a bloodvessel, either by an embolus or a thrombus. For similar reasons to those mentioned with regard to hæmorrhage, we may discard the notion that softening from thrombus has produced the symptoms. Nor is it probable that embolism is at the root of the matter, for there is an absence of the usual history and concomitants of such a condition; so that, by a process of exclusion, it is reasonable to suppose that the symptoms are due to the presence of a small tumour, and, if so, what is the probable nature of the tumour?

First. It may be *syphilitic*; but then we should expect to have a history of syphilis, and to find other manifestations of that disease—such as deep ulceration of one tonsil, nodes on the superficial bones, a tubercular eruption on the skin, or the like. We should also expect the pain of the head to be nocturnal in character. In connection with syphilis, too, the sixth and the third nerves are specially liable to be involved. If there was still any doubt, the result of an antisiphilitic treatment might decide the point.

So much for acquired syphilis; but the tumour may be the result of a taint hereditarily transmitted. In that case, however, we should probably have had a history of miscarriages in the mother, and of manifestations of syphilis in the infantile period; we would almost certainly have found other evidences of hereditary syphilis in addition to the cerebral symptoms—such as pallor of the skin, cicatrices upon the face and at the angles of the mouth, stunted growth, prominence of the brow, corneitis, sunken nose, notched teeth, etc.

Secondly. It may be *tubercular*; but tubercular tumours of the brain most frequently occur between the ages of three and seven years, and there is often a hereditary tendency to tubercular disease. Other manifestations of this diathesis are likewise frequently present, as in the following case reported by Sir Thomas Watson:<sup>1</sup> “I attended,” says he, “with Dr. Latham, a youth whose symptoms led us to believe that he had tubercular disease of the peritoneum. We thought it probable also, although there were no *physical signs* of pulmonary disease, that

<sup>1</sup> *Lectures on the Principles and Practice of Physic*, Fifth Edition, Vol. I., p. 380.



his lungs contained crude tubercles. After some time he went down to the coast, and was there attacked with a fit of general convulsions. Up to that period he had shown no symptoms whatever indicative of organic disease within the head. On being apprised of this seizure, we expressed in a letter to the physician then attending him that it had resulted from the presence of scrofulous tumours in the patient's brain. The convulsions returned a few days afterwards with great violence, and the boy died. It was as we had conjectured. The peritoneum was found studded with innumerable miliary tubercles; there were a few crude tubercles, of some size, around the root of the lungs, and two large masses of the same sort in the brain."

In connection with this point it may be well to bear in mind the rule, to which there are few exceptions, that after the age of puberty there is more or less evidence of tubercular disease in the lungs when other organs are attacked. Lastly, were the tumour tubercular, we should expect to find elevation of temperature, although not to so marked an extent as when other organs are involved.

Thirdly. The tumour may be *cancerous*; but cancerous disease generally occurs in persons over forty years of age, and is accompanied by a cachectic appearance, which is not present in our patient. In some cases, too, there is a hereditary tendency to cancer, or (exceptionally) cancer is detected elsewhere.

If tumour there is, then, it is probable it is neither syphilitic, tubercular, nor cancerous. What, then? All that we can say is, that in young adults, if we are able to exclude syphilis, a tumour of the brain is generally benignant in character (glioma, etc.).

In the treatment of this case, therefore, no attempt was made to cause the tumour to disappear. All we could do was to treat symptoms and complications. We gave her a course of strychnia, and, as the bowels were constipated, we combined it with sulphate of magnesia.

The paralysed side of the face was also galvanised every second day, and a series of blisters were applied alternately in front and behind the ear. Soon after the commencement of the treatment the pain in the head and the paralysis of the

extremities disappeared, while the paralysis of the side of the face was considerably modified. At the time of her dismissal she was in the most perfect health, the only symptoms remaining being partial paralysis of the portio dura nerve.<sup>1</sup>

Finally, it must be admitted that the rapid disappearance of the paralytic symptoms suggests the possibility of the symptoms being dependent upon an inflammatory lesion at the base of the brain.

## CASE 2.

### TUMOUR OF THE MEDULLA OBLONGATA.

On the 4th June, 1881, a student of divinity, aged thirty-seven, was admitted into the side-room of Ward II. with a very unusual train of symptoms, the cause of which it will now be my endeavour to elucidate. One morning, about three years ago, on wakening, he observed that he had a left internal squint: slight at first, it gradually became more pronounced, so that, at a distance of fifteen feet, images appeared one yard apart, but in about four or five months it in great measure disappeared, unless after a bad night's rest. Shortly after this he had for a time some confusion of ideas, and very slight pain in the back of the head and upper part of the spine, which was followed in a few months by drowsiness, to such an extent that he was constantly falling asleep; this drowsiness gradually deepened into a sort of stupor, from which he was aroused with some difficulty. This symptom, too, about the same time to a

<sup>1</sup> Dr. Thomas Reid examined the eyes of this patient with the ophthalmoscope, and with the following result. There was hypermetropia (one twentieth) in both, and in both thinning of the choroid. The vision of the left was reduced one-half, but there was no special defect in any region of the field of vision. The papillae in both were oval-shaped, and the vessels were accompanied in both by white streaks. The upper and inner aspect of the left disc was slightly cupped, and occupied by a network of cicatricial tissue continuous with the white streaks accompanying the vessels. Dr. Reid thought that the symmetrical character of the abnormal shape of the discs pointed to congenital or local, rather than intracranial causes. The intraocular changes, viewed by themselves, might be accounted for by the hypermetropia; but, in the light of the other symptoms, it was also possible that they were due to some general cause, syphilitic or other.

great extent passed off. About the beginning of the present year he suffered from loss of appetite, indigestion, and occasional vomiting, which confined him to bed for a few weeks, on leaving which he observed for the first time that he had some difficulty in walking. Two months ago he "sprained his left leg," when he took to bed again for a couple of weeks, chiefly, as he says, "on account of the shock which it gave him." Since then the difficulty in walking has been more marked, not on account of any loss of power in his limbs, he thinks, as they seem to him to be "as strong as ever they were," but on account of giddiness, and an inclination to fall, sometimes backwards, sometimes forwards, but oftenest backwards. The day before he hurt his leg he had two "nervous attacks," and, while in bed on account of the injury, he had eight or ten more, all of which closely resembled, though they were more severe than, one which he had the day after his admission, of which the following is a brief outline:

About 4.30 A.M., on the day in question, he began to suffer from hiccough and severe frontal headache, with uneasiness in the eyes and tingling in all his extremities. About 8 A.M. he began to expectorate large mouthfuls of clear, sometimes frothy, tenacious saliva. The salivation continued more or less all day, about two hand basins full in all being expectorated. During the attack he vomited once a small quantity of beef-tea shortly after its ingestion, the eyes watered very much, and the eyelids and conjunctivae were congested, while the pupils, especially the right, were observed to be contracted. The skin at the commencement felt hot, but slowly cooled down. Unfortunately at this time no record of the temperature is preserved, but during his residence in hospital the temperature was sometimes above the normal, and on the night of his admission was 101.4.

Latterly he has complained of a noise like machinery between his temples, and vomiting has been a frequent symptom: this he attributes to constipation, which has troubled him all through his illness.

He is a tall, lanky, melancholy-looking man, who has a rather stupid, apathetic look, except when he speaks, but he answers questions very intelligently. He has great difficulty

of walking for the reason before mentioned, and also because the left knee is almost completely ankylosed, as the result of an inflammatory affection which set in when he was about nine years old, and continued for about half-a-dozen years.

The disease from which he suffers evidently involves quite a number of cerebral nerves: the sixth nerve on each side is paralysed, as he is unable to turn the eyes outwards; and the third nerve, particularly the fibres supplying the internal recti, is likewise involved, as he is unable to turn the eyes inwards; indeed, the range of movement of the eyeballs is exceedingly limited, and what little power of movement remains is chiefly in a vertical direction. An ophthalmoscopic examination was made by Dr. Thomas Reid, who sent the following report: "*Left eye*.—Optic nerve slightly oval, major axis vertical, rather pink in colour, and not quite translucent, vessels rather diminished in size, especially veins, with some little irregularity in the distribution of the pigment. *Right eye*.—Slightly myopic, with a little tendency to congestion." It will thus be seen that there was no evidence of optic neuritis.

Further, as first noticed by the patient two or three months before admission, there is very decided loss of power of the right side of the face—so decided, that one might almost have taken it for a case of Bell's paralysis, such as results from exposure of the side of the face to cold; but that the paralysis of the facial nerve is due to a central lesion is demonstrated by the fact that the muscles respond readily to both currents of electricity. There is, too, a suspicion of implication of the glosso-pharyngeal nerve, as, for the last two or three months, he has had some dysphagia, especially on swallowing solid food, while the left spinal accessory is completely paralysed, as shown by the inaction and marked atrophy of the trapezius and sternomastoid muscles of the left side, especially the former. The urine, it should be added, though rather pale, and containing a few phosphates, is otherwise normal, and contains not a trace of sugar.

*The Seat of the Disease.* A consideration of the symptoms just enumerated leads to the inference that the disease is situated at the base of the brain, and in the vicinity of the pons varolii or medulla oblongata.



*The Nature of the Disease.* With regard to this point there is more difficulty in arriving at a conclusion, further than that the disease is a tumour of some kind. There are certain tumours, however, which, in all probability, we may exclude. Thus it is probably not syphilitic, for, although implication of cerebral nerves, and particularly of the third and sixth, are common in this condition, there is no nocturnal pain, nor is there any history of syphilis, and a most careful examination fails to detect any trace of other manifestations such as are commonly met with in that disease. Nor is it likely to be cancerous, as we find neither hereditary tendency to it, nor any evidence of cancer elsewhere, although the latter point is of no great value as a negative feature, seeing that cancer of the brain is generally solitary. There is, too, a total absence of the cachexia so frequently present in such cases, while the age of the patient is below that at which it is most commonly met with. This is well shown by the statistics of Walshe, who found that of 56 cases of cancer of the brain, 26 occurred between the ages of 40 and 60. It might, however, be of a tubercular nature, for although we cannot trace any hereditary tendency to that diathesis, there has been some elevation of temperature throughout the disease, such as we usually find in connection with tuberculosis, and there is reason to suspect that the anchylosis of the knee resulted from strumous disease in early life. If not tubercular, it is probable that we have to deal with a benignant tumour of the nature of a glioma, or sarcoma.

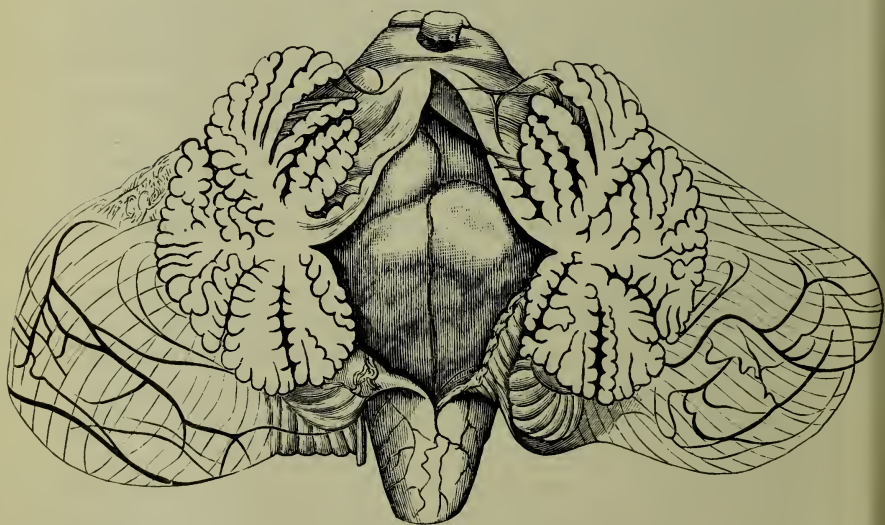
If the diagnosis is correct, little can be hoped for in the way of treatment, and we have therefore to content ourselves with palliative measures, one of which only is worthy of mention, viz., the subcutaneous injection of  $\frac{1}{100}$ th grain of sulphate of atropia daily, which has, in great measure, arrested the profuse salivation.

[*Sequel of the Case.* This patient rapidly went down hill, and died on the 17th June, a week after the above remarks were penned.

The post-mortem examination was made by Dr. Joseph Coats, who reported as follows: "Leave was only obtained to

examine the head. The body is emaciated, and there is great thickening and distention of the left knee-joint.

"*Head.* There is considerable oedema of the soft membranes, and the ventricles are greatly distended with a clear fluid. There is no exudation at the base, and the brain substance in general is normal in appearance. In particular there is no appearance of the nerves being involved at their points of issue from the pons or medulla. On laying open the fourth ventricle by an incision carried through the cerebellum in the middle line, a bulky tumour is found in its floor. It occupies the greater part of the floor of the ventricle, its greatest length and greatest breadth being about an inch. Its middle is slightly below the middle of the cerebellum. The tumour is much more bulky on the right than the left side, and the middle line is pushed considerably over to the left. On its surface the tumour is nodulated, and has a bluish colour. It feels somewhat firm to the touch, but it is not cut into at this stage."



The preparation was hardened in alcohol, and the following is Dr. Coats' report of the section: "The tumour was divided from before backwards, the section being made through the

pons and medulla so as not to interfere with the appearances as presented in the fourth ventricle. To the naked eye the structure is not obviously different from that of normal nervous tissue, and in particular there is no caseous material. There is indeed no obvious demarcation between tumour and nervous structure. Under the microscope the tissue of the tumour is seen to consist of an intricate network of fine fibres with very occasional round or oval nuclei—the structure being that of a simple glioma.”]

### CASE 3.

#### CASE OF CEREBELLAR DISEASE, PROBABLY TUBERCULAR.

M. C., aged seventeen, was admitted into Ward VII. of the Western Infirmary, on 8th February, 1895, complaining of stiffness in the legs, and frequently recurring headaches, of two years', and of a tendency to fall backwards, of about six, months' duration.

Neither the family nor the personal history has any special bearing on the case.

The illness commenced two years ago with gradually increasing stiffness, and a peculiar feeling in the frontal region, which she describes as “dizziness.” She declares that, when coming down stairs, it was difficult to avoid falling forwards. (This sensation of falling forwards was probably the result of exaggerated attempts to overcome the tendency to fall backwards.) She has also suffered from headaches, so severe at times that she was compelled to leave her work and go home. They came on markedly after exertion, occasionally when at rest, and were generally relieved by purgatives. Early in the illness she noticed tremor of the upper extremities on exertion, so that, in carrying a cup of tea, she required to exert herself to overcome both tendency to fall, and the tremor. She has noticed, also, some tremor of the lower extremities, but it is not marked.

The gait is peculiar. She walks in a very hesitating manner, and is inclined to fall backwards and towards the right side,

saving herself by stepping back with the right foot at about every alternate step. The whole appearance of the body suggests an effort at balancing, and although it is quite obvious that the real tendency is to fall backwards, the patient says that if she attempts to hurry she feels she must fall forwards. With the feet close together, and even when allowed to stand as she likes, she at once falls backwards on closing the eyes.

*Reflexes.* The knee-jerks are, if anything, exaggerated, and there is a slight tendency to ankle clonus.

*The Speech.* There is an almost indefinable hesitancy in the speech, which has been noticed only since the illness began.

*The Optic Nerves.* There is double optic neuritis of the lighter type. The effusion is small in amount, but unmistakable. There is no diminution of visual acuity complained of.

The only treatment adopted was absolute rest in bed, with cod liver oil and syrup of phosphorus.

*Progress.* By 6th March the patient was able to walk some distance up the ward without support, and with very little tendency to fall backwards.

On 12th April still further improvement was evident. The gait was rather slipshod, but almost free from inco-ordination.

The neuritis was subsiding.

She was dismissed on 25th April, at her own request. Scarcely any abnormality in the gait was then to be noticed.

The treatment adopted in this case was based upon a suspicion that the disease was tubercular in its nature, and the improvement which resulted seems to be in the direction of corroborating the accuracy of this view.

#### CASE 4.

##### CASE OF CEREBELLAR DISEASE.

A. L., aet. ten, was admitted to Ward II., Western Infirmary, on 26th September, 1895, complaining of staggering gait, loss of vision, frontal headache, and persistent vomiting, these symptoms having commenced in February, 1894.



Father, aged forty-three, is well and in excellent health. Mother, aged forty-one, has been confined to bed for many months with chronic rheumatism. Four children are alive out of a family of five. The child who is dead succumbed to bronchitis at the age of sixteen months. There is no history of miscarriages or anything pointing to syphilis.

In infancy patient was troubled with bronchitis, and at two years of age he had measles, otherwise he has been in good health till the onset of the present illness, which commenced with a fit of vomiting, in February, 1894. Since then he has had frequent attacks of vomiting, always preceded and accompanied by frontal headache and with prostration. He has sometimes been free from vomiting for as long as ten days, and at times he has vomited almost incessantly for twenty-four hours. A doctor, who was consulted in the month of April, said he was suffering from water in the head, and applied a blister to the nape of the neck. Five days before admission, when he was getting out of bed, his father noticed that his gait was very unsteady, and that he tended to fall to the left side. His eyes also at this time became affected, as he could not distinguish members of the family standing beside him. He also became dull and heavy, and tended to sleep a great deal. Of late he has been increasing in weight, and his appetite has been excellent. His father has never noticed any discharge from his ears. He has never suffered from diarrhoea, his bowels rather tending to be costive. He has had no trouble with micturition, and sensation does not seem to have been at any time impaired.

On admission he is seen to be a well-nourished, healthy-looking boy, but there is marked anterior rickety curving of both tibiae, and there is a scar on the front of the left fore-arm. There is no paresis of any part, but rather inco-ordination. He is unable to stand with his heels together, and when walking he lifts his feet rather high, and puts them down suddenly in a staggering fashion, as if he were afraid he was going to fall. Mostly, he tends to fall to the left side or backwards, but, when he is asked to wheel about, it is not found that he wheels uniformly to the left side. There is no inco-ordination in the movements of the upper extremities. Sensation seems to be

quite normal in all respects. Superficial reflexes normal; deep reflexes normal, except the knee-jerks, which are markedly deficient, the left being almost absent. There is no difficulty in swallowing or speaking. Hearing and taste normal.

*Eyes* (examined by Dr. Hinshelwood). "Optic neuritis in both eyes of moderate intensity, most marked in right."

12th November. "Optic neuritis which has passed the acute inflammatory stage, and is now in the stage of retrogression."

*Treatment:*

Sept.	27.	Ordinary diet and rest in bed.			
"	30.	Pot. iodidi.	2 grs.	t.i.d.,	p.c.
Oct.	24.	"	5	"	"
Nov.	11.	"	10	"	"
"	25.	"	20	"	"

*Present Condition*—11th March, 1896. Since Christmas, the headache, vomiting, and giddiness have disappeared. He walks much more steadily, and has no tendency to fall either to the left side or backwards. Knee-jerks are now fairly active and equal. He can stand quite well with feet together. The condition in both eyes is that of post-papillitic atrophy. There is now nystagmus, most marked on lateral movements.

## CASE 5.

### MALIGNANT TUMOUR AT THE BASE OF THE BRAIN, WITH SECONDARY NODULES IN THE LIVER.

W. S., aged forty-six, by trade a ferryman, was admitted to Ward II. on 23rd January, 1893, complaining of headache of eight, and loss of sensation on the right side of the face of six, months' duration.

His father died, at the age of fifty, of cancer of the stomach; his mother, at forty-six, of some form of heart disease. They had a family of three—two brothers and a sister. The brother died in childhood; the sister is alive and well. The patient is married, and has had eight children. Of these, one died before



the age of three months, one was still-born, and a third died, like the first, before the age of three months.

His past health has been excellent. Until six years ago he was employed as a dock labourer, and, although much exposed, never had more than an occasional cold. He then became a ferryman, and for some time drank considerably, but he has latterly been more temperate.

In May, 1892, he began to complain of pain in the right ear, unaccompanied by any discharge. For this he was treated for a time, but without effect, and in the course of a month or six weeks he became completely deaf on that side. About the same time he suffered much from headache. The pain was very severe, and made him feel as if the head would burst. It was almost continuous, but much aggravated at night. At first it was confined almost entirely to the right frontal region. Since its onset the pain has hardly ever been completely absent. Of late it has extended to the left frontal region, where, however, it is less severe; and it still preserves the nocturnal character.

In June, 1892, a fulness appeared on the right side of the neck, between the angle of the jaw and the ear. Its size was variable, the swelling being now very marked, and now almost absent. It never caused any pain. Blisters, which were several times applied, reduced it only temporarily. A similar swelling above the outer part of the right clavicle has existed, he states, for many years. A month or so after the appearance of the fulness described, the patient began to notice a loss of sensation in the right side of the face, which was accompanied by loss of power in the muscles. The two symptoms very gradually grew worse, and it was not till three or four months later that anaesthesia and paralysis were complete. In September, 1892, the right eye became affected. It was turned inwards towards the opposite side, and about the same time his sight became a little dim.

His general health remains good, although there is slight constipation.

On examination, the whole of the right side of the face is found to be paralysed. He cannot wrinkle his forehead, nor draw up the angle of his mouth, which is pulled towards the

left when he attempts to do so. Food lodges between the right cheek and the gums. Anaesthesia extends over the whole of this side of the face to the middle line. It involves the ear, and is continued on to the head for about three inches beyond the margin of the hair. The right side of the nose and the neighbouring part of the cheek are much swelled and inflamed, and the right nostril is the seat of a discharge which forms dark-brown crusts about the orifice. There is complete ptosis on the right side, and internal strabismus. The eye cannot be rotated outwards, and its upward movement is slightly impaired, but all the other motions are perfect. The eyeball is much congested. The pupils are equal. Dr. Reid reports that on the right side the vitreous is muddy, the nerve pale and atrophied, and the vessels congested. There is no papillitis, and the left nerve is normal. Dr. Barr, who examined the ears, reports that the right-sided deafness is due to chronic catarrh of the middle ear, and not to involvement of the auditory nerve. There is a glandular enlargement between the angle of the jaw and the ear. The tumour, of older date, above the clavicle is a sebaceous cyst.

No history of syphilis is obtainable, but on examination of the trunk an eruption is found, which consists of spots and blotches like iodic acne, but darker in colour than usual. The rash was produced by iodide of potassium administered before admission.

Dr. Anderson diagnosed a tumour at the base of the brain on the right side, involving the fifth and sixth nerves, the portio dura of the seventh, and the third partially, and possibly syphilitic, on the following grounds:

- (1) The history of patient's children (two deaths at three months and one still-born, all within the last six years).
- (2) The number of cranial nerves involved.
- (3) The nocturnal character of the headache.
- (4) The characters of the iodic eruption.

For the first few days the patient was given the following pill:

R.—Hydrarg. perchlor.,	-	-	-	-	gr. ii.
Ext. cinchonae,	-	-	-	-	5 i.
Divide in pil. xxiv. Sig.—Two daily.					

Under this treatment there was a distinct improvement in intelligence, and the headache disappeared. The other symptoms remaining unaltered, daily inunction of a drachm of mercurial ointment was begun on 30th January. The congestion of the eyeball then diminished rapidly, as did the inflammation of the nose and the discharge therefrom. For some time the glandular swelling also diminished, but on 18th February it increased in size to a considerable extent, and the skin over it became inflamed. Up to 20th February neither paralysis nor anaesthesia had been at all affected by the treatment.

From this date onwards there was no further improvement. The glandular swelling in the neck, enlarged yet more, softened in the centre and was opened, giving vent to a considerable quantity of unhealthy pus. The incision did not heal, and there was a constant purulent discharge.

In March the right eye became the seat of an acute inflammation of the cornea and iris, which resulted in complete loss of sight. The general health, meantime, did not show much alteration, although the patient became somewhat thinner and weaker. He remained in much the same condition until the evening of 5th May, at 9 P.M., when he suddenly became unconscious, passed into a state of profound coma, and died at 10.40.

*Post-mortem.*—*Head.* The convexity of the brain presents nothing remarkable. On removing the brain, considerable adhesion to the dura is discovered. The adhesions are almost limited to the right side, being as follows: The optic commissure is adherent in the sella turcica, and the pituitary body seems to be involved in adhesions and new-formed tissue. The right temporo-sphenoidal lobe is adherent on its internal and inferior surfaces. The pons is adherent on the right side, and there is softening and some haemorrhage visible on its surface; whilst on section a grey tumour-tissue is visible in the form of a more or less rounded nodule three-eighths of an inch in diameter, extending into the substance of the pons for about a quarter of an inch. The left lobe of the cerebellum is also adherent, and somewhat softened on its under surface. The corresponding portions of the dura are thickened, infiltrated, and adherent to the bone, which is considerably swollen and

softened, so that a needle can be pushed into it in various places to a distance of from half an inch to three-quarters of an inch.

*Liver.* The right lobe presents at its anterior edge, and at the extreme right, a tumour mass two inches in diameter at the surface of the edge, and one and a half inches from without inwards. It is obviously composed of a congeries of coalesced tumours, the individual diameter of which may be in general from a quarter to three-eighths of an inch. The under surface of this region shows a rounded tumour, consisting of somewhat isolated nodules, some of which extend as far as two inches outwards from the tumour. None of these exceeds three-eighths of an inch in diameter. In addition, there are visible at the surface, at wide intervals, a few scattered tumours, mostly of small size, whilst on section there are also visible a few tumours. In the portal region of the liver there is a group of enlarged and apparently infiltrated glands.

The other organs present nothing remarkable, save that the pericardium contains 10 oz. of clear yellow fluid.

On cutting deeply into the right side of the neck, where a suppurative condition is visible, two or three glands enlarged and infiltrated with grey tissue are observed. There is slight enlargement of the mesenteric and inguinal glands.

Microscopic examination of the tumour in the base of the skull proved it to be carcinomatous, originating probably in the sphenoidal sinus.

### CASE 6.

#### TUBERCULAR TUMOUR OF THE CEREBELLUM, WITH MENINGITIS AND TUBERCULAR DEPOSITS IN OTHER ORGANS.

W. A., aet. twenty-four years, was admitted February 13th, 1896, complaining of giddiness and dinness of vision beginning in October, 1895, followed at the end of December by discoloration of the skin.

One of his brothers died, aged fifteen, of some chest trouble, and a younger brother suffered from what seems to have been *tabes mesenterica*.



Eight years ago he had a transient attack of paraplegia of short duration, from which he made a good recovery. During the last five years he had been troubled at intervals with ulceration of the sole of the right foot.

In October, 1895, he first began to be troubled with giddiness and dimness of vision coming on particularly after he began to look steadfastly at any object. It occasionally improved, but latterly gradually got worse. Shortly after the onset of the giddiness and dimness of vision, he began to suffer from attacks of vomiting, most frequently in the morning, but sometimes in the evening. The attacks extended over a period of three weeks, after which they did not recur. The vomiting was unassociated with either pain or nausea.

After this he gradually became weaker and was confined to bed, being unable to stand. He observed also that he had been becoming gradually more yellow. His bowels became very constipated, and his motions very pale. For a week before admission he suffered from headache, chiefly frontal in situation, and with nocturnal exacerbations.

On admission he was considerably emaciated and complained greatly of weakness. On testing his lower limbs in bed, there was no great loss of power, but simply a general muscular weakness, which was shared by both upper and lower limbs.

He was markedly jaundiced with yellow skin and conjunctiva. There was well-marked bile reaction in the urine, which was yellowish green in colour, and his stools were pale.

The liver was enlarged and tender, especially in the region of the gall bladder.

The knee-jerks were almost abolished, there being only a very faint response. The cutaneous reflexes were active.

There was well-marked nystagmus, which, however, was only observable on lateral movements of the eyes, and he complained considerably of headache, always worst at night.

He became gradually weaker, and died on 25th February, eleven days after admission. About three days before his death he was semi-comatose, the coma gradually deepening until it became profound, it being impossible to rouse him, and he passed his motions and urine in bed.

During the period of his stay in hospital, his evening

temperature was generally about  $100^{\circ}$  F., with normal temperature in the morning.

On post-mortem examination, the following changes were found:

The base of the brain showed a very marked meningitis, which extended from the neighbourhood of the optic chiasma into the sylvian fissures, and anterior longitudinal fissure. On examination of the sylvian fissures tubercles of some age were discovered as large as millet seeds, and there was considerable softening of the brain substance and some yellow coloration. In the substance of the left lobe of the cerebellum a tubercular tumour of an oval shape measuring  $3.5 \times 3$  c.m. was found. It readily shelled out, the tissues around being soft. A small rounded tumour measuring 1.3 c.m. in diameter was found in the frontal lobe on the left side. Both of these had a marked greenish colour (jaundice).

There was tubercular infiltration of both lungs, especially at the apex; the condition was almost uniformly in the stage of grey granulation, no cavities being found.

In both kidneys there were a few tubercles of some size and caseating, but no general dissemination. The prevertebral glands generally were much enlarged, and there was a great mass in the neighbourhood of the first part of the duodenum. The head of the pancreas was buried in this mass, which was also adherent to, and partly incorporated with, the common bile duct, exercising considerable pressure upon it. The gall bladder was greatly distended with an almost black viscid bile. The liver showed, as viewed from the surface, numerous pale nodules of small size, and similar nodules were visible on the cut surface. There was a moderate amount of biliary infiltration of the organ.

The ulcers on the sole of the foot presented all the appearance of tubercular ulcers.



## CASE 7.

## CEREBRAL TUMOUR REMOVED BY OPERATION.

A. K.,<sup>1</sup> aged sixteen, engineer's apprentice, was admitted to Ward II. of the Western Infirmary, on August 14th, 1890, complaining of fits and of paresis of the left arm and leg. No definite neurotic tendency can be traced in the family beyond the fact that his mother suffers frequently from headache, and that for a number of years he himself has been similarly affected, apparently as part of "bilious attacks." There is no history nor are there evidences of syphilis or tuberculosis. There is an indefinite history of slight discharge from the ears during infancy, but all traces of this have been absent for a number of years.

About four years and a half ago, without previous warning, and while in the act of lacing his boots, his left forearm was suddenly flexed, and, uttering a cry, he fell down in a semi-insensible condition, conscious, to a certain extent, of what was going on around him, but unable to speak or move. Ever since this fit he has complained at times of slight pain, numbness and weakness in the left hand, and within the last year or so this had been more frequent and severe. The pain and its accompanying numbness are usually experienced in the left thumb and forefinger, and, only when severe, extend to the rest of the hand and forearm.

No recurrence of fits took place till a year and a half ago, when, on May 10th, 1889, a second occurred. This was preceded by lateral oscillation of the head for about two hours. Pain and numbness were then complained of in the left thumb and forefinger, which gradually extended upwards through the left hand and forearm to the arm, finally affecting the left side of the face, including the left half of the tongue. He remembers uttering a cry and falling, and a quarter of an hour later he woke up, unconscious of what had happened, and complaining of headache and nausea. A third fit occurred on the following day, and fourteen days later a fourth. These all

<sup>1</sup> Reported by the resident medical officer, Mr. L. R. Sutherland, M.B., C.M.

began in a similar manner, and had much the same character and duration.

Alarmed about this state of matters, he sought admission to hospital on June 11th, 1889, and was under treatment by mixed bromides, gr. v., increasing to gr. xv. t.i.d. till August 3rd, 1889, when he was dismissed much improved. While under observation on this first occasion he had only two fits. These were ushered in by pain in the left thumb and forefinger, extending up the arm towards the head. The actual fit was apparently a generalized convulsion, said to have been attended by sobbing and profuse perspiration.

A fortnight after leaving hospital the fits returned, and have since continued to recur. At times intervals of from eight to sixteen weeks elapse, at others they occur daily, even though he may be under the influence of bromides. The fits, since he left hospital, have differed from the previous ones in so far as there has been no loss of consciousness. The aura has continued as before.

For a month before his readmission the numbness and pain in the left hand and forearm have been becoming rapidly worse, and partial paralysis of the left arm, gradually extending to the leg, has developed.

During the ten weeks he was under observation in hospital for the second time eighty-nine fits occurred. From August 21st to September 17th there were no fewer than eighty-seven, on an average three daily. Under the influence of treatment they gradually became less frequent, and finally ceased. For three weeks no fits occurred. On October 10th, and again on the 26th, a slight recurrence took place, all treatment having been suspended on the 21st.

*Examination.* The limbs of the affected side are somewhat flabby and cold. There is very decided paresis of the left arm and hand, the dynamometer registering on the right 50 kilos, on the left *nil*. Quite distinct, but less decided, paresis can be made out in the left leg on resisting movement. There is exaggeration of the left knee and wrist jerks, slight left ankle clonus, and the superficial reflexes are active. Tactile sensation is perfect. A feeling of numbness is experienced all over the left side, particularly in the arm and leg, and to a less

extent in the left side of face and left half of the tongue, but this is not constant. There is slight facial paralysis on the left side as estimated by the usual tests. There is slight deviation of the uvula to the left, and the tongue, on protrusion, is slightly deflected to the affected side. Pain, at times very acute, is complained of behind and above the right ear and in the right frontal region, and, at a point two inches above and behind the ear, an area of distinct tenderness is discovered on percussion.

The following are the results of the examination of the eyes, ears, and urine :

*Dr. Hinshelwood's Report on the Condition of the Eyes* (September 11th, 1890). "Well-marked optic neuritis present in both eyes, but all the changes are most marked in the right. The papillae are swollen, and the normal cupping of the discs entirely obliterated. The edges of both discs are obscured, so that it is impossible to make out where the retina begins and the disc ends. The papillae are of a deep greyish-red colour, but towards the outer part are surrounded by a palish halo. The veins are dilated, and the arteries are smaller than normal. The retinae, for a considerable distance round the optic discs, have lost their transparency, and have an opaque greyish appearance, which gives a very dull fundus reflex on ophthalmoscopic examination."

*Dr. Barr's Report on the Condition of the Ears* (October 29th, 1890). "Right ear: Hearing power slightly under the normal; tympanic membrane fairly normal; no perforation, cicatrix, or any evidence of present or past purulent disease. Bone conduction good. The tinnitus is probably connected with some form of irritation at the auditory centre in the brain. Left ear: Pear-shaped cicatrix in tympanic membrane; rest of membrane opaque. There are indications of a past purulent disease of the middle ear. Hearing power more impaired than on the right side."

*Dr. W. F. Somerville's Report on the Urine* (October 30th, 1890). "A. K.; amount of urine examined, 1·2 litre in twenty-four hours; colour, palish amber; odour, urinous; reaction, neutral; specific gravity, 1022.

"*Result.* I have neither seen the patient, nor do I know

any clinical particulars of the case. From the examination of the urine, according to the method recommended by Mr. A. E. Haswell, pathological chemist, Vienna, I find evidences of brain irritation, as shown by the increased excretion, relatively and absolutely, of the earthy phosphates, caused, perhaps, by the presence of a tumour, or by the pressure of bone on the brain-substance; or possibly, though not likely, by a very old encapsuled abscess. From the light colour of the urine, the specific gravity, the amount of urine voided in twenty-four hours, the relatively decreased urea, and the increased chlorides, the possibility of any suppurative process, as one would find in a case of abscess or of meningitis, can be quite excluded."

	In per Mille.	Grms. in 24 hours.	
Water, - - - - -	948.8	1148.5	
Dry residue, - - - - -	51.2	61.4	
Organic material, - - - - -	33.5	40.2	rel. abs.
Ash, - - - - -	17.7	20.2	+ n.
Extractive material, - - - - -	7.3	8.7	sl. + sl. +
Urea, - - - - -	25.2	30.2	- -
Chlorides, - - - - -	11.1	13.3	+ +
Sulphates, - - - - -	3.0	3.6	- -
Phosphates, - - - - -	3.67	4.4	n. sl. -
Uric Acid, - - - - -	-		
Pigments, - - - - -	n.		
Albumen, - - - - -	none.		
Sugar, - - - - -	"		
Ammon. carb., - - - - -	+		
Alkali phosphates, - - - - -	2.46	2.95	sl. - sl. -
Alkaline earth phosphates, - - - - -	1.21	1.44	+ +

NOTE. + = increased; - = decreased; rel. = relatively to dry residue; abs. = absolutely in twenty-four hours; sl. = slightly; n. = normal.

In reference to diagnosis, the points which we have specially to consider are two: first, the seat; and secondly, the nature of the lesion.

1. *The Seat of the Lesion.* The disease is manifestly cerebral, and implicates the right side of the brain, as the resulting manifestations are almost exclusively on the left side of the body, while the paralytic phenomena indicate implication of the motor tract. But what part of the motor tract is the seat



of the mischief? The symptoms point, I think, very positively to the cortex cerebri. For it must be borne in mind that in cortical lesions convulsions are very common, are frequently limited, at least at their onset, to the part whose centre is irritated, and consciousness is often retained, factors which are all present in our patient. In such cases, too, a sensory aura often precedes the epileptiform seizures, and in this instance the fits set in with numbness and pain in left thumb and fore-finger.

This last circumstance, coupled with the fact that the paralysis began in the left arm, points to a lesion having its centre about the junction of the middle with the lower third of the ascending parietal convolution. This conclusion is somewhat supported by the pain which was complained of, and by the tenderness on percussion above and behind the right ear, although it must be remembered that the seat of pain does not necessarily correspond with the seat of the disease.

2. *The Nature of the Lesion.* The history of suppurative disease of the middle ear naturally leads to the suspicion that there might be a cerebral abscess; but this suppuration occurred on the *left* side, and in early life, a good many years before there were any symptoms of cerebral irritation; while Dr. Barr's report furnishes evidence of prolonged absence of active disease of the middle ear. So that we may almost certainly exclude the hypothesis of abscess of the brain, more especially as Dr. Somerville's report on the urine is decidedly against such a view.

That being so, we can come to no other conclusion than that we have to deal with a tumour of some kind. The most common forms of cerebral growth are tubercular or syphilitic in their nature, and these might possibly be influenced by the inoculation of Koch's fluid on the one hand, and anti-syphilitic treatment on the other. But there is no history of a hereditary tendency to tubercular disease, nor is there any indication of a delicacy of constitution in the patient himself. And, as regards syphilis, there is no history or symptom of hereditary transmission of the taint, nor is there any suspicion of the disease having been acquired, not to speak of the age of the patient which, of itself, almost excludes it. A cancerous growth

is out of the question, as the patient presents none of the characteristics of malignant disease, nor does there appear to be a family predisposition thereto.

If, then, we are right in our view that the tumour is neither tubercular, syphilitic, nor cancerous, all that we can say further is that the intracranial growths which are most commonly met with are glioma or sarcoma; and the only way of getting rid of them is by operative interference.

#### OPERATION BY PROF. GEORGE BUCHANAN—AS DESCRIBED BY HIMSELF.

In the preparation of the patient, the steps of the operation and the after-treatment, I followed rigidly the plan described by Victor Horsley, and had every reason to be satisfied with the result.

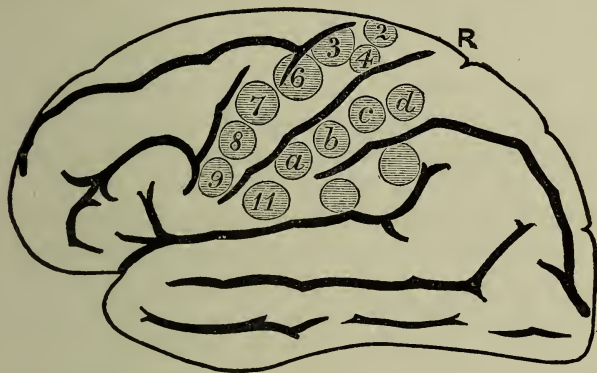
Three days before the operation the head was shaved, to allow me to study the topography of the cranium. The point at which I proposed to open the cranium was fixed on by the following measurements: the distance between the root of the nose and occipital protuberance was divided into two equal parts; half an inch behind the centre point, indicating the upper end of the fissure of Rolando, was marked. From this point a line was drawn downwards and forwards at an angle of  $65^{\circ}$ ; this indicates the direction of Rolando's fissure. Three inches down, just behind this line, are situated the convolutions indicated in Dr. Ferrier's plan as those presiding over the movements of the thumb and finger. These spots and lines were marked with a blue pencil. The scalp was then thoroughly cleansed, and a wet compress of carbolic solution kept on continuously.

On October 30th, the day preceding the operation, the bowels were cleared out with castor oil, the head was again shaved, cleansed, and kept moistened with carbolic acid solution.

The operation was performed on October 31st, at 9.30 A.M. Immediately before this he had a quarter of a grain of morphine subcutaneously, which is believed to have some effect in controlling haemorrhage from the vessels of the brain.



The patient having been put under chloroform, I made a semilunar flap of the scalp, including the aponeurosis, the upper part of which was near the vertex, the base about 3 inches wide, across the lower part of the fissure of Rolando, that is, just on a level with the top of the pinna. One or two small arteries were ligatured. The pericranium was turned aside from part of the skull, where a trephine was applied, just at the spot previously determined by the surface marking.



2, 3, 4, Centres for the movements of arms and legs; 6, Centre for supination of hand and flexion of forearm; *a, b, c, d*, Centres for hand and wrist; 11, *a, b, c, d*, are on the ascending parietal convolution behind the fissure of Rolando, R. The tumour was situated under *a*.

The trephine was rather larger than a shilling. The button of skull which was removed was placed between folds of lint moistened with carbolic solution, and kept warm. The dura mater exposed by the trephine and the convolutions beneath seemed to be perfectly normal, and presented no evidence of any tumour or lesion. Thinking that the diseased area might be further up, behind the fissure, on the centre indicated for the arm, I applied the trephine two inches above and behind the former situation, and removed a similar disc of bone. I then applied a Hey's saw on each side in a line touching the outside of both circles, and with a lever removed the intervening bridge of bone. All the pieces were kept moist in warm carbolic solution. I now clipped the dura mater for four-fifths of the circumference of the oval aperture, about a sixth of an inch from the edge of the bone, and so exposed the cerebral

surface. At no part was there indication of any abnormal condition, nor on pressing it with the point of the forefinger was there any evidence of either fluctuation or undue resistance. But at the lower part, just in the centre of the first trephine hole, the cerebral convolution seemed to bulge a little, and while feeling it with the smooth end of a director it suddenly burst asunder, and a dark red or brownish body resembling an Orleans plum emerged from below, and pushing aside the cerebral substance, which seemed to have been extended over it, occupied the lower part of the opening. With my finger and thumb I found I could move it in the brain, and with the spoon-like end of a large director I lifted it out of its place, without tearing anything and without any hæmorrhage. It was regular and nearly globular, smooth on the surface as if enclosed in a thin capsule, and was about the size of a walnut. It was evidently removed entire without any breaking or bruising, as the cavity from which it came contained no *débris*, and it closed at once by resiliency of the surrounding substance.

After washing the wound with a stream of antiseptic fluid, I sewed the dura mater into its place with stitches of fine silk. It came together edge to edge, except at a small part where it had been torn. I now replaced the discs of bone in their situation, and filled up the space between them with pieces of the intervening bridge of bone, which I had cut into four or five portions. The semilunar flap was then put into position, and retained with fine silver wire stitches, a little opening, into which I put a drainage tube, being left at the posterior angle. A dressing of alembroth gauze and Gamgee cotton was applied with a very slight pressure. The patient stood the operation well, and his progress to recovery was almost uninterrupted.

The specimen, says Professor Coats, is a soft, fleshy piece of tissue of a reddish colour; its surface is irregular, having a granular appearance, which on closer inspection looks almost papillary; at least there are a number of regular flat elevations of very small size. The tumour is a flat mass of a generally triangular shape, having somewhat the outline as well as the size of the suprarenal body. Its longest diameter is one and a half inch; its other diameter one inch, and its thickness half

an inch. The tissue is very friable, and there is no defining capsule.

A portion removed by scissors from the surface shows the tissue to be very vascular, numerous capillary vessels forming a reticulated network. At the surface the vessels show what looks like papillary projections. Between the vessels, and to some extent clothing them, are large quantities of cells which are of considerable size, and contain large oval nuclei.

A portion of the tumour was hardened in absolute alcohol imbedded in celloidin, and sections made with the microtome. The sections stained readily with logwood, alum carmine, Bismarck brown, etc.

The tissue contains numerous vessels, and each vessel is surrounded by a mantle of translucent tissue sparsely provided with cells. This tissue in specimens mounted in Canada balsam is homogeneous and structureless in appearance, but in glycerine it is seen to have a finely fibrillated character. The thickness of this mantle varies considerably, in some places equalling the diameter of the vessel, in other places much less.

The tissue generally consists of cells mostly oval or spindle-shaped. Between the cells there is the merest trace of intercellular substance consisting of reticulated fibres. The papilliform appearance noted in the fresh state is not borne out in hardened specimens; and it was due, doubtless, to the fact that at the torn edge of the tissue, the vessels with their mantle presented themselves individually.

From the character of the tumour, it may be regarded as a spindle-celled sarcoma, but taking into consideration the mantle around the vessels, it belongs to the group Plexiform Sarcoma.

# ON PERCUSSION AND AUSCULTATORY PERCUSSION OF THE SKULL IN DIAGNOSIS AND TREATMENT.

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CAN we act on the structures within the skull by simple percussion of the head by the finger? Will the force of such a stroke as can be used with safety not simply be diffused over the bone without being transmitted through it? These are questions which may be readily suggested by the title of this paper. It therefore seems necessary to answer them at the outset. In this connection the results of concussion of the brain from injury are worthy of consideration. In most cases there is more or less bruising or laceration of the cerebral tissue. This shows the effect of a severe blow. Duret's<sup>1</sup> observations on cerebral traumatism are however more exact in their indications. He concluded from careful and laborious experiment that at the point of sudden impact a *cône de dépression* is formed, which passes through the interior in the line of the thrust to the base of the skull. But it is to clinical facts chiefly that we look for evidence of the effect of a slight stroke. Cases have been recorded by others as well as myself which show that in disease of the cortex of the brain and pia mater, the dura mater, and inner table of the skull, either singly or combined, we can, by the mere tap of the finger on the head, produce an impression on the parts within,

<sup>1</sup> H. Duret. *Etudes expérimentales et Cliniques sur les traumatismes cérébraux*. Paris, 1878.



which may be painful, though previously the patient had not felt pain in that situation.

Obviously it is in the diagnosis of the group of intracranial morbid conditions just named that this method of investigation might be expected to be useful. It is now many years since, by communications to the medical societies and the showing of patients, I directed the attention of the profession in Glasgow to its value in this connection; and at the London meeting of the International Medical Congress in 1881, I submitted a more formal paper on the subject.<sup>1</sup> Since then considerable experience of its use, both in Glasgow and elsewhere, has accumulated, which will be briefly stated. But before doing so it may be well to make more particular reference to the action of percussion.

It is clear that an impression is made on the sensory fibrils in the portion of the scalp which is tapped—the branches of the fifth, the auricular, or the occipital nerves, according to the region under examination. We will consider the area of the fifth. It will be remembered that it is also the sensory nerve of the underlying bone and membranes, both dura and pia mater. The impress of the tap in ordinary conditions is at once transmitted to the great sensory centre in the convolutions where it enters into consciousness. But in morbid states of the corresponding part of the pia or dura it may, in its central progress, at the first station of the afferent

<sup>1</sup> Published in the transactions of the Congress. In the course of the meeting Dr. Ferrier wrote to me that in 1874, in a paper on "Pathological Illustrations of Brain Functions" in the West Riding Asylum Reports for that year, page 54, he had recorded that pain might be elicited by percussion of the skull in the case of morbid growth within. In justice to him I quote his brief remark on the subject:—"The seat of pain, however, does not always coincide with the position of the tumour. In reference to this symptom of cerebral disease, much may be learned by percussion of the skull. On several occasions, by smart percussion, I have been enabled to determine approximately the seat of the disease, and sometimes brought out local pain, though not formerly complained of." It is clear, therefore, that Dr. Ferrier is entitled to the credit of priority of observation on this point. But he made no suggestion as to general percussion of the skull, nor directed how percussion should be done, nor mentioned the risks of being misled, nor advised any precautions against what might prove to be a dangerous error, were it acted on in practice.



nerve from the scalp be partially reflected downwards on the nerves coming from the seat of disease, or on their nucleus in this station. So far as we at present know, the first meeting place of the external and internal branches of the fifth, where such a transference might take place, is in the Gasserian ganglion.

Possibly in certain cases the morbid part may be awakened into activity through this circuitous route. Its afferent nerves, at least as far as the nucleus, are likely to be in an unduly susceptible state. The recent observations of Mackenzie and Head into the relations of internal organs or parts of organs to definite cutaneous areas, long ago to a considerable extent anticipated by Hilton in his classical work on "Rest and Pain," lend support to this hypothesis. There is also corroborative evidence in the facts of disease; for example, the reflected pains down the arm in some forms of cardiac trouble. However, it is less obvious that the irritated state of nerves in cutaneous areas is reflected on their correspondents in internal organs than the converse, namely, that the morbid condition of the organs within may be in some cases revealed by paraesthesiae or hyperaesthesiae of well defined external surfaces. But probably this reflection of the external on the internal, in disease of the latter, by short circuit from the nearest station, is more common than is generally recognized, and should be borne in mind as a serious possibility in cutaneous affections. No doubt there will be little or no action if the internal organ or tissue is healthy, but if it is in a morbid state, the outside malady may not improbably exert a baneful influence on the progress of the internal one, should it be seated in its cutaneous neural correspondent.

But though directing attention to this as a possible route of the impress in superficial intracranial disease when the skull is percussed, I certainly think that, in the great majority of cases, it is directly transmitted to the seat of lesion. Still, while granting this conclusion, it may be urged as an objection that the cerebral substance is altogether insensitive, and that the investing membranes are only slightly sensitive. This is doubtless true of the brain in health, and, so far as is known, in disease also; as is evinced in *hernia cerebri*, where a patient

may have a slice of his convolutions cut off without experiencing any sensation. The membranes, likewise, when exposed, show little evidence of sensibility. But it is otherwise in disease, especially when subjected to tension, as then they may give rise to pain, which occasionally becomes excruciating.

The pain, it will be observed, is elicited by percussion. Mere rubbing of the part or gentle pressure does not induce it. It is therefore inferred that the disease is not in the bone, unless it be in the inner table of the skull, and if this part be affected it is of great importance that the fact should be known, as morbid action there usually involves the outer and often the inner membrane, as well as the brain itself. However disease of the bone in adults in most cases is syphilitic, and the pain, as a rule, is so considerable as to stand in no need of artificial development to manifest its existence.

We now proceed to describe how percussion of the skull should be practised. Either the middle or forefinger may be used, and the tap given by its point should be of very moderate force, always less than will of itself induce pain. If the physician is not familiar with this mode of investigation, he would do well to first percuss his own head to ascertain the character of the stroke which can be borne without discomfort. It will be observed that it may be of somewhat greater force over the vertex than at the sides of the head or on the brow. In the latter situations it should be gentle, and care ought to be taken to avoid the lines of the supraorbital and temporal nerves.

In the practice of this mode of diagnosis there is considerable risk of being misled in certain cases. Frequently little reliance can be placed on the impressions or imaginary impressions of hysterical patients. In no case, either by word or otherwise, should it be suggested that one part of the head is more likely to be the seat of pain than another. It is always advisable, even though a patient be very decided in pointing to one spot, to verify the conclusion by a second examination. The whole head should be percussed, bearing lightly on the more impressible parts already mentioned. If these precautions are exercised, and the patient still adheres to

his previous statement with obvious conviction, the physician is justified in basing his diagnosis to a large extent on this indication.

Some illustrative cases will now be submitted. In several the indications of local pain were elicited by the tapping, the patient being previously unaware that there was pain in that situation; in a number there was more or less general but indefinite pain, which was localized by its intensity on percussion; while in another group there was slight pain in a particular spot before the tapping, but much more severe for a short time after it.

\* J. W., age thirty-eight. This patient was subject to convulsive seizures, affecting the right arm and leg every three or four weeks. The disease was probably of syphilitic origin. He stated in answer to definite inquiry that he did not suffer from headache, yet when the head was tapped all over with the finger, he without hesitation defined the limits of an area where the tapping was distinctly painful. This was situated on the left side, and was about three inches above and behind the highest part of the left ear. Nowhere else was there any unpleasant sensation, and the patient, who was an intelligent man, was quite unaware that there was any exceptional condition in the region mentioned till his attention was directed to it by the percussion. Besides constitutional treatment ten cantharides blisters were applied in rapid succession over the painful region, and he said they had done him much good. He was dismissed apparently well after being some months free from seizures.

\* H. B., age twelve. This boy was struck with a piece of brick on the left side of the head, about four inches above the summit of the ear, and half-an-inch in front of the parietal eminence. Within a month he became subject to epileptic "absences," and rarer convulsive seizures which began by his head turning to the right. For some weeks he had pain, which at first was severe, but after some weeks passed away. Percussion, however, brought back the pain in an aggravated form, though it subsided in a few minutes. Trephining of the skull was

\* Cases marked with an asterisk were shown at meetings of the Clinical and Pathological Society in Glasgow, and have been already published.

advised, but his father would not consent to the operation being done.

W. H., age thirty-nine. Patient stated that he had been subject to fits about once a fortnight for some years. For a day or two before they occur he has a heavy, severe pain across the middle of the head, extending to about two inches above each ear, which when the attacks are imminent becomes aggravated, and seems to pass from the right to the left side. The seizures begin in the left arm, then pass to the left leg, and thereafter become general. There is no pain in the head, except near the time of the fits. In a free interval the head was percussed with the finger. This developed very distinct pain in an area about midway between the upper part of right ear and middle line of the head. The patient left the hospital before there was time to test the effects of treatment.

\* J. R., age twenty-eight. Patient has been subject for upwards of three years to attacks of Jacksonian epilepsy, affecting chiefly the left arm and hand, at about weekly intervals. He has also suffered often from headaches during that time, but the pain was generally diffused throughout the head in the attack, and he cannot say that one part is sorer than another. Pain was developed by percussion of the head, which was localized in a region not very sharply defined above the right ear and a little in front of it. Though this was anterior to the line of the motor convolutions, it was still sufficiently near it to support distinctly the conclusion as to the site of the lesion derived from the character of the convulsive movements.

Dr. McCall Anderson<sup>1</sup> records a case of cerebral tumour in which he states that the diagnosis was "somewhat supported by the pain which was complained of, and by the tenderness on percussion above and behind the right ear." Dr. George Buchanan successfully removed the tumour by operation.

The kind of case in which cranial percussion has proved most useful in my experience is illustrated by the following brief record:

A lady, age fifty, was accidentally struck on the parietal region of the head by a piece of iron, about two years before coming under my care. She was nervous since the accident,

<sup>1</sup> *British Medical Journal*, March 14th, 1891.



suffered much from headache, and life had become miserable. On careful examination it was clear that there was a little weakness of one leg; but neither the arm nor the face was affected. On the opposite side of the head, about the place where she was struck, percussion was clearly painful. A series of fly blisters was applied over this spot, and she ultimately made a good recovery.

In concluding this portion of my subject, I remark that wherever there is the least ground, judging from the general symptoms, for suspecting that disease may exist superficially within the skull, percussion of the head should not be omitted. Failing any result, no harm will have been produced; when successful, it singles out the part to which, in some instances, remedial applications may be made, with the wellfounded anticipation that not seldom the disease may at least be alleviated, if not removed, while in others it helps to determine the place where surgical operation is required.

#### DIFFERENTIAL PERCUSSION CRANIAL NOTE.

Professor Macewen has drawn attention to the presence of an altered cranial note in distension of the lateral ventricles by fluid. In his work on *Pyogenic Diseases of the Brain and Spinal Cord*, he has given a very full account of its mode of production. Here I shall briefly summarize what he has there stated, and will also submit the result of my own observations on the subject.

Dr. Macewen remarks that when the skull is lightly struck by the tip of the middle finger, the resulting note is modified by the consistency and volume of the contents, and their relative position to the bone. A thin cranium vibrates more easily than a thick one. In the cranium of the infant the percussion note is so slight, dull and flat, as scarcely to be perceptible. In healthy children a dull sound is produced, which is nearly equal all over the cranial vault. In some who are either healthy or at least have no obtrusive diseased condition, a slightly more resonant note results from percussion over the side of the head a little behind and above the upper



and outer angle of the orbit. In healthy adults the note is generally high pitched, imparting the idea of solidity, but in many the bones of the cranium are too thick to permit active vibrations on ordinary digital percussion. It is pointed out that in many, but not all, ricketty children the percussion note is more resonant than normal. In some, where the clear percussion sound was elicited, it was afterwards proven that the lateral ventricles contained fluid, which in these cases was believed to give rise to the peculiarity of the note. In others it was supposed to be due to the porosity of the bone.

It is, however, where the lateral ventricles are much distended with serous fluid that the resonance is greatly increased, and then has a somewhat hollow character. It also varies according to the position of the head. If the head be held much to the side, the note is clearer on the lower one, and if reversed, is dull on the same side when it becomes the upper. In over forty children and young adolescents who have had distended ventricles, this clear percussion note has been found.

Such is a short summary of Dr. Macewen's views and experience on this point. I can fully corroborate his statement regarding the distinctive character of the note where the distension of the ventricles is well marked. Besides seeing some of his earlier cases, in which the special note was very obvious, I have had patients under my own care in whom it was present.

The distinguishing character of the note is less clear where the quantity of fluid is not large. Further, as Dr. Macewen has pointed out, it is sometimes simulated in the large head of rickets. In this condition, as I have seen post mortem, the brain substance may be very soft, much less consistent than normal, and this probably modifies the sound independently of excess in the amount of ventricular fluid.

I have found that the distinctive properties of this or other sound brought out by percussion of the skull, are more evident on listening with the stethoscope at the time the head is tapped than with the unaided ear, especially in cases of dubiety. Putting the stethoscope over the frontal suture at the upper part of one side of the head, a few gentle taps should be made

with the tips of the fingers on the corresponding part of the other side. Though the characteristic note is usually best brought out between these two points, sometimes it is more clearly elicited by altering the line of vibration across the head; and this may be done by moving the stethoscope from one part to another, or changing the place of percussion with the fingers.

Adopting the title which is given to this combined mode of auscultation and percussion, when used in helping to determine the extent of the area occupied by a dilated stomach, I have named it when applied to the cranium—Auscultatory Percussion of the Head.

In health the sound heard by this mode of examination differs materially in youth and mature years. With a view to determine the effect of age in modifying the sound, about five years ago I examined fifty individuals, thirty of whom were children under twelve, and twenty adults. In the child the sound is more hollow and the resonance greater than in the adult. In the latter the vibration is usually comparatively slight. As already mentioned, the conduction of vibrations is most free across the summit of the head about its middle. It is less obvious if, while listening on one side, percussion is made on or around the opposite parietal or frontal eminence, especially the latter.

Macewen's characteristic note, as we have seen, points to the presence of excess liquid within the skull. This is most commonly the result of chronic hydrocephalus, but it may be due to other causes, such as occlusion of the foramen of Magendie, or pressure on the veins of Galen by a cerebellar tumour.

From its relation to the subject under consideration, it may be here mentioned that, in moderate but increasing hydrocephalus, the scalp, particularly over its middle region, may be found soft and relaxed to the touch, and more movable than usual.<sup>1</sup> This is probably analogous to the relaxation of the vagina, os uteri, and other parts at the beginning of parturition

<sup>1</sup>At a meeting of the Glasgow Pathological and Clinical Society on November 14th, 1892, I showed two patients in whom the distinctive note was present, and best heard by auscultatory percussion. In one of them, a girl of sixteen, the scalp was in the condition described.

which in them at least is to be attributed to the provision of nature that prepares them for the process of stretching at a later stage of labour.

"Auscultatory percussion may prove of use in the diagnosis of other lesions which modify the conduction of vibrations along the bones, for example, superficial haemorrhages and new formations in the bone, membranes, and cortex. These, if considerable, may be likely to interfere with the transmission of vibrations. Thus a subdural effusion of blood consequent on injury or apoplectic seizure," or a subcortical collection of pus, "may modify the note by its pressure on the overlying bone, and, if so, the alteration of sound would be a guide to the point at which the operation of trephining the skull should be performed."<sup>1</sup> My colleague, Mr. Henry Clark, mentioned to me that he had a case in which he demonstrated a definite area of dulness on percussion above the ear. He trephined the skull in that situation, and evacuated a large quantity of pus from the temporo-sphenoidal lobe. Other symptoms also pointed to a collection of pus in that situation. The patient made a good recovery.

#### PERCUSSION OF THE SKULL IN TREATMENT.

In considering the question of diagnosis it was shown that we can act on the tissues beneath the skull by a slight tap on the head by the finger. This suggested that percussion so practised might prove useful in treatment. It seemed not unlikely that its slight stimulating impression on the cerebral cortex, if continued for a considerable time, might gradually produce a remedial effect. There were further the action on the sensory nerves of the scalp and the arousing of the patient's attention, both of which might be beneficial.

This digital percussion of the skull was begun in the small asylum under my charge in June, 1893, and since then has been used in twelve cases. They were all women, and the majority suffered from chronic melancholia, the others from stuporose insanity or dementia. Three melancholics recovered, and one of them spontaneously attributed her recovery mainly

<sup>1</sup> Quotation from my paper in the *Lancet* of January 7th, 1893.

to the tapping of the head. In the other two the melancholia was apparently becoming fixed when the cranial percussion was commenced. In a fourth woman, who had for many years suffered from combined melancholia and stupor, there was a marvellous clearing of the faculties after a few days tapping of the head. But she passed into a state of mania, and ultimately died from Bright's disease, which was probably present when the percussion was begun. Two others improved, but in the remaining six there was no appreciable change.

In relation to diagnosis, directions have already been given as to how this mode of percussion should be practised. They are equally applicable to treatment. I would only further add that in the latter it should be limited to the upper and central convexity of the head, from the occiput to the brow. I repeat that it is not advisable to tap on the sides of the head lest any nerve trunk should be struck, as I once did on my own head; the part was sore for several days afterwards. However the risk of injuring nerves is but slight, as, so far as I am aware, in no patient or attendant has it ever happened. The attendants are also referred to, as I have always asked them to percuss their own before percussing the patients' heads, so that they might fully appreciate the force of the stroke which should be used. This method of treatment should be repeated *at least* three times a day, and for about a minute at a time. In some of my patients it was continued for five or six weeks.

## CASE OF GRANULOMA FUNGOIDES.

By D. C. M'VAIL,

Physician to the Royal Infirmary.

WITH A BACTERIOLOGICAL REPORT BY W. D. MURRAY, M.B.,  
AND PHOTOGRAPHS BY D. MOUNCEY ATKINSON, L.R.C.P. & S.ED.

CHARLES M'A., forty-three years of age, was admitted on July 8th, 1897. Father, two brothers, and six sisters all in good health, mother died at the age of seventy from "some internal complaint."

Patient, with the exception of scarlet fever when fifteen years of age, and a short febrile attack whilst harvesting fifteen years since, and a two weeks' attack of influenza seven years ago, had always been in perfect health.

He has never been abroad, but has spent his life as a shepherd in Islay and Cantyre.

His present condition followed on an injury in June, 1896, due to a sheep, while he was shearing it, kicking him on the right temporal region. The skin, he said, was not to appearance broken, but within ten minutes "a raised bruise," the size of a sixpence, appeared where he had been struck. It was not painful, and was freely movable with the skin. There was no surrounding redness and no feverish symptom. At the end of a month it had increased to the size of a shilling, and at that time he observed a dusky reddish blotch, the size of a threepenny piece, on the outer surface of the left upper arm, three inches above the condyle. This was not inflamed, and at first did not project beyond the level of the surrounding skin. A fortnight subsequently he felt a projecting surface over the vertex of the head, a week later



another—the fourth—appeared over the left parietal bone. During all this time he had no constitutional symptoms except that he felt somewhat apathetic, and that, if he took even a small quantity of whisky, he experienced headache in the parietal region, which lasted during the remainder of the day.

Two days after the fourth swelling, about seven weeks after the kick, an attack of what looked like erysipelas of the face appeared. The skin became first blue, then rosy red and swollen; he shivered and vomited repeatedly during a week.

At the end of the week the face began to improve, but if he exposed himself out of doors he shivered slightly, and the face flushed painfully.



PLATE I.

For these reasons he was practically confined to the house for three months, during which time the four slight swellings of the skin above described did not greatly increase in size.

In February, 1897, the swelling on the left parietal began

to extend backwards to the occipital region, and to project much more, and new swellings appeared over the frontal region and on the eyelids.



PLATE II.

In April the parietal swelling had become as large as half an orange, and all the other projections had increased in corresponding degree. In May the nose and eyelids began to enlarge; in June the condition of the head and face became

what it was on admission to the Infirmary, and small elevations had risen on various parts of the trunk and limbs.

Plates I., II., III., IV., and V. show the condition of the parts on admission. In general there was considerable symmetry



PLATE III.

of the two sides of the face. The nose was four times its normal size, the cheeks protruded like fists, and just above the nose was a projection like an egg. The projection over the original seat of injury was also of egg size. The lobes of the



ears were enlarged. The growths over the coronal region were somewhat excoriated, and bled slightly. The others were dry, nowhere scaly. The colour was generally dusky red. The swellings were entirely in the skin, and movable with it, that over the occipital region being least movable.



PLATE IV.

Over the arms were scattered irregularly maculae and tubercles, varying in size from a lentil to a bean, and on each upper arm a much larger projection, that on the left, which is shown in the photograph, being larger than that on the right.

Over the surface of the body there were small elevations, more numerous on the anterior than on the posterior surface.



PLATE V.



The photograph shows the condition of the thighs and legs, the elevations varying from the size of a threepenny bit to that of a florin.

Examination showed the lungs, heart, liver, and spleen to be normal. There was a faint cloud of albumen on admission, and this recurred occasionally. The temperature was  $100^{\circ}$  on admission, but fell to normal on the second day.

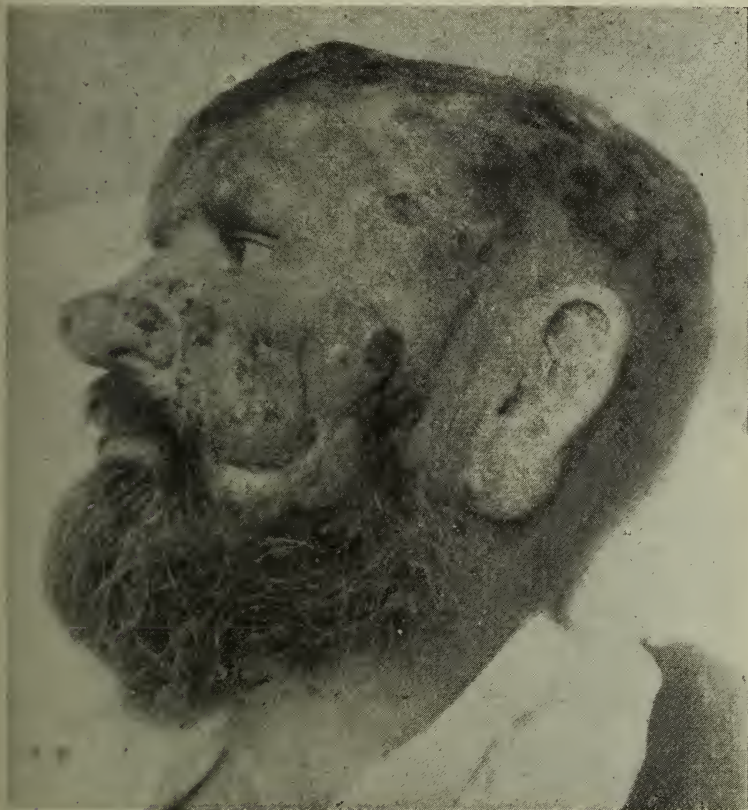
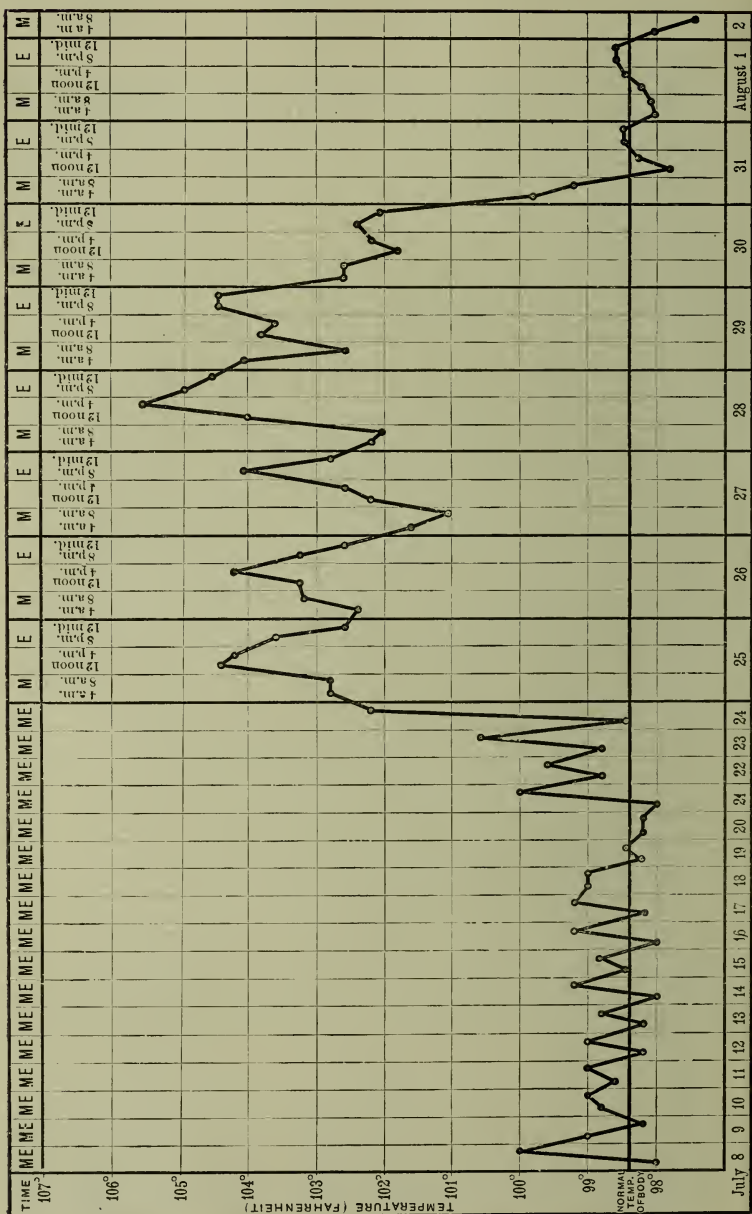


PLATE VI.

Examination of the blood showed 4,500,000 red corpuscles, and one white cell to 300 red discs, and haemoglobin 60 per cent. of the normal.

Skin scrapings were examined, and also a small portion of



deeper structures, and gave on this occasion no bacterial results. The growth consisted of round, and some spindle cells, with thin walled vessels. There was no history nor evidence of syphilis. There was some slight enlargement of the inguinal, axillary, and cervical glands.

From his admission he was put on iodide of potassium and chaulmoogra oil.

The condition remained unchanged and the temperature practically normal from the date of admission, July 8th, till July 21st, when the temperature showed  $100^{\circ}$ . On the 23rd it was  $100.4^{\circ}$ , and on the 24th it rose to  $102.4^{\circ}$ . On this day he was somewhat stupid and drowsy, and coughed a little. He had also picked at the swellings on the head and face, causing them to bleed slightly, and the growth had become more dusky than before. During the 25th, 26th, and 27th he continued drowsy for the most part, and wandered in his talk, and occasionally was wildly delirious, and the evening temperature was  $104^{\circ}$  or slightly over, and on the 28th reached  $105.6^{\circ}$ .

By the 27th the swellings had greatly diminished in size, those on the body having fallen to the level of the surface, and generally they were less dusky than before. Plates VI. and VII. show the condition of the tumours on July 27th.

On the 29th the temperature was  $104.4^{\circ}$ , on the 30th,  $102.6^{\circ}$ , and on the 31st it fell to normal and continued normal.

He became clear and coherent when the fever disappeared. The iodide of potassium and chaulmoogra oil were continued until the temperature rose, afterwards the iodide was persevered with and the oil was omitted. Through August he continued well in health, and the growths did not increase, but in September they again began to enlarge, and by October 6th they were as shown in Plates VIII. and IX.

His health was good on September 24th. Chaulmoogra oil was resumed. In the first week of October portions of the tissue were again submitted to bacteriological examination, and the following is Dr. Wm. D. Murray's report:

"By drawing off a little fluid from the deeper parts of a nodule in the head, smear preparations and pure cultures of a bacillus having the following characters were obtained:



"A plump rod with rounded ends, varying in length from 1 to 2.5  $\mu$ ., and having a tolerably constant thickness of about .75  $\mu$ ." In smear preparations made from the fluid

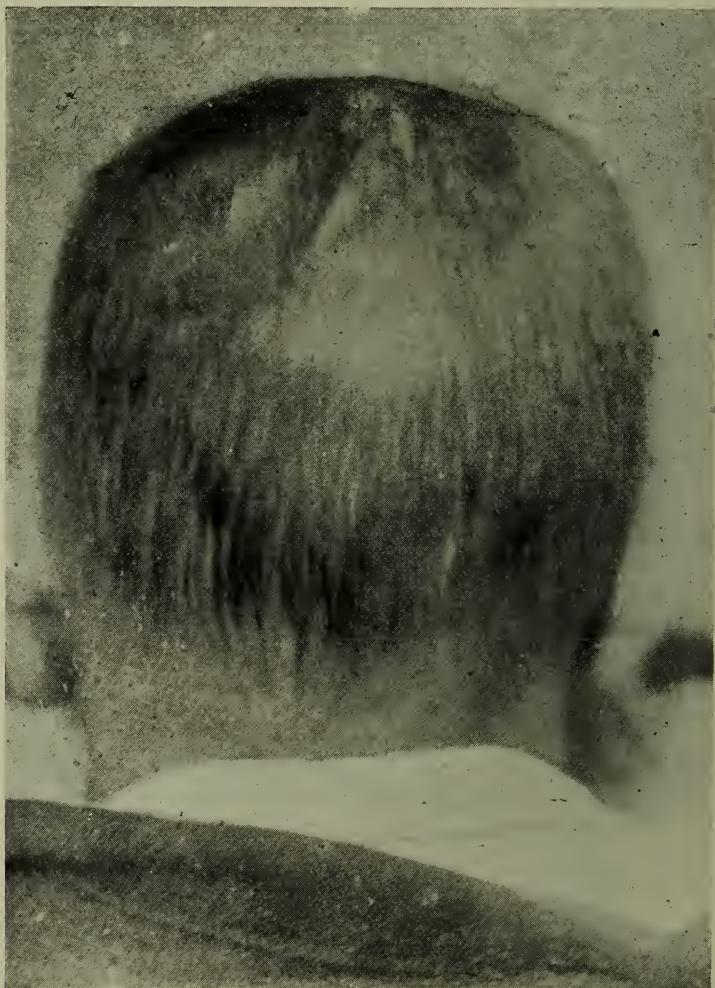


PLATE VII.

and in sections prepared by the pathologist, Dr. Workman, it is generally seen singly or in pairs, while in cover glasses made from cultures it also sometimes forms long threads.

"It is aerotic (but grows with difficulty under anaerotic conditions), sluggishly motile, possesses spores, and grows on ordinary culture media readily at room temperature, but more rapidly in the incubating oven.



PLATE VIII.

"On agar, in twenty-four hours, at 37°C., small rounded greyish-white colonies develop along the streak. These rapidly coalesce, and in a few days spread freely over the surface of the slope. The growth on the gelatine plate is quite distinctive. In twenty-four hours round, creamy-white, pin-head colonies develop on the surface and in the depth of the gelatine. Under the low power these colonies are



granular, with ill-defined margins, the deep colonies, however, being more definite than those on the surface. From the margin short, fine, hair-like rays shoot into the gelatine in all directions. About the third day these rays can be seen by the



PLATE IX.

naked eye, and about this time liquefaction sets in. When the colonies become surrounded with a zone of liquefied gelatine, which usually happens in from seven to ten days, growth apparently ceases. In a gelatine stab the growth is abundant, with minute rays projecting into the medium. Liquefaction

begins at the surface, and having gradually developed a funnel-shaped cavity reaching the bottom of the stab, growth again evidently stops. In a gelatine shake culture the rays give an appearance somewhat resembling tetanus colonies. In potato a thick growth soon shows. This at first is very pale in colour, but in a few days it becomes of a light-brown tint, with a smooth, shining surface.

"The bacillus stains readily with the aniline dyes, and is not decolorized by Gram's method. By special staining flagella can be shown. These are few in number, usually only three or four to each bacillus. In old cultures spores are easily stained by the usual methods.

"Only a few experiments on rabbits have yet been made. These go to show that when a little of a culture is rubbed into the skin, previously scratched, there is no result; but when an emulsion containing two to three m-grammes of the bacillus is injected subcutaneously on the head, then, in eight or ten days, a distinct swelling at the point of inoculation takes place. This increases slowly, and is followed by secondary nodules along the line of the post-cervical glands. In about twelve to sixteen days the animals sicken and die, with no marked general symptoms; and on post-mortem examination the lymphatic glands are found to be greatly enlarged, forming small white tumours under the skin. In these glands the bacillus is found in small numbers. Intraperitoneal injection causes death in about forty-eight hours, with localized peritonitis and enlargement of the surrounding glands in which the bacillus is found. The organism does not seem to invade the circulation, as cover glass preparations and cultures, made from the blood in the heart and from the spleen, gave negative results."

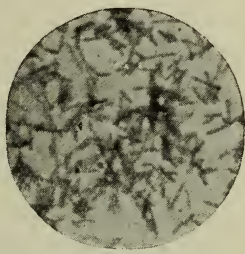


PLATE X.

Plate X. shows the bacilli. On October 6th he left the Infirmary, refusing to stay longer. After leaving the Royal Infirmary he remained in Glasgow till he died, and Dr. McConville, who saw him, writes as follows :

"I saw M'Arthur twice after he left the Royal on October 6th, the first time about the 20th of October, and on the second occasion about the 23rd of November, a fortnight before his death, which occurred on the 8th of December.

"M'Arthur's appearance was very much changed. He was very much emaciated and exceedingly anaemic.

"The soft, livid swellings over the face, trunk, and limbs were more general, and scattered over the body were a great number of ecchymosed patches, but not raised above the skin.

"The patches, unlike the soft, livid swellings, had all the appearances of the markings one sometimes sees in bad cases of scurvy. M'Arthur steadily declined, and died from exhaustion on 8th December, as above stated."

The points of importance in connection with this case of granuloma fungoides are:

(1) That it was immediately due to the kick of a sheep, and that so far as could be ascertained there was no disease of any kind amongst the sheep at the time.

(2) That the deformity of the face was unprecedented.

(3) The great lessening of the swellings during a short, sharp febrile attack. Whether the fever was the cause or the consequence of this, or was unconnected with it, is matter for speculation.

(4) The rapid return at the end of a month of the swellings to almost the size they were on admission.

(5) The good general health maintained during his residence in the Infirmary, with the exception of the short febrile attack, and the rapid decline of health in the last weeks of his life.

(6) The new bacillus that was found in the growths, and its production of growths in rabbits, and the death of the rabbits.

(7) The treatment by iodide of potassium and chaulmoogra oil until the fever occurred, and the decrease in size of the growths. The iodide was gone on with and the oil stopped, and only resumed a few days before he left the Infirmary, after which he did not continue it. In other cases recorded there has been temporary improvement under iodide, and generally again increase in size of the skin tumour, and usually—not always—death from general exhaustion.

## ON THREE CASES OF SUDDEN BLINDNESS.

By A. MAITLAND RAMSAY, M.D., F.F.P.S.G.

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IN this communication it is not my intention to deal with cases where, as in sick headache or uraemic poisoning, blindness is sudden of onset but transitory in character, and the eyes affected may show on ophthalmoscopic examination no sign of disturbance. In the three cases that follow the loss of vision was more or less permanent, and the ophthalmoscope clearly revealed the cause of the disorder.

### I. EMBOLISM OF THE CENTRAL ARTERY OF THE RETINA.

On the 28th October, 1896, a girl, seventeen years of age, and a winder by occupation, consulted me on account of sudden loss of sight in her right eye. She said that on the previous night she had returned from work in her usual good health. Suddenly, without pain or fore-warning of any kind, while she was cutting bread for supper, she experienced a sensation as if a cloud had passed rapidly before her right eye, and on looking up and closing the left, she found that the eye affected was quite blind. She was unable to distinguish light, and ophthalmoscopic examination revealed a peculiar greyish-white pallor over the whole retina, except the macula, which presented a characteristic cherry-red appearance, and the optic disc, which was simply blanched. There was, however, a remarkable absence of exudation, so that the contour of the disc was sharply defined. The veins were of normal size, but the arteries were so much contracted that they resembled delicate red threads. The case was evidently one of complete embolism of the central artery



of the retina; but how this had originated it was difficult to determine, as careful examination revealed nothing whatever of an abnormal nature connected with heart, lungs, or abdominal viscera. The girl herself had never suffered from rheumatism, but her medical attendant informed me that she had a very rheumatic family history.

In the hope that, if the bloodvessels were suddenly dilated, the embolus might be dislodged, the patient was kept in bed, and tabloids, each containing  $\frac{1}{100}$  grain of nitro-glycerine, were administered three times a day. Although the drug seemed to act well no change was apparent until the morning of the seventh day from the beginning of the treatment, when the patient suddenly discovered that she was able to see the nurse, who was standing at the foot of the bed. Tests showed that she could now count fingers when they were held in the temporal side of her field of vision, but every test object was lost to sight immediately she looked straight at it. Corresponding with this improvement in sight, there was a change in the ophthalmoscopic appearance of the fundus oculi, in the nasal side of which there was now a faintly rosy tint, and the arteries were distinctly larger than on the temporal side. All the arteries were bordered by white lines. The macula also, although quite distinctly visible, did not present such a marked contrast in colour to the surrounding parts. The bright cherry-red formerly noted had faded away considerably, and round about this region were a few light yellow spots with here and there a minute shining dot, which from the manner in which it glistened was probably a crystal of cholestearine (Fig. 1). It was evident that, whether as a result of the treatment or not, the embolus had been displaced, and that a small stream of blood was entering the arteries which supplied the nasal portion of the retina; and in the hope that nitrite of amyl by inhalation would have a more prompt effect in dilating the smaller bloodvessels, it was determined to substitute this for the nitro-glycerine tabloids. As, however, at the end of a fortnight no further improvement of vision could be detected, its use was discontinued, and the patient allowed to get out of bed. Iodide of potassium in doses of five grains three times a day was then prescribed, and by the end of



November the patient could make out large letters—No. 20 Jaeger. In order to see them, however, she had to rotate her eye slightly inwards. An attempt was at this time made to map out the visual field by means of the perimeter, but this proved, owing to the patient's inability to "fix" an object, a matter of considerable difficulty. A chart of irregular shape, extending to  $10^{\circ}$  in the temporal side, was however obtained.

A rosy tint was distinctly visible all over the fundus, but the coloration was deeper in the nasal than in the temporal side; and this heightening of the colour of the surrounding parts had taken away much of the distinct definition of the macula, while it made the optic disc appear by contrast more blanched than ever. The outline of the disc was still quite sharp, and the lamina cribrosa was clearly visible. Just at the point where the ascending temporal branch of the retinal artery passed over the margin of the disc, the course of the blood-stream seemed interrupted by a minute plug, which was, in all probability, a fragment of the original embolus. From this time onwards there was practically no change to be noted in the ophthalmoscopic appearances, but the patient affirmed that she was sure her sight was improving. This improvement, however, was taking place wholly to the temporal side, and perimetric measurement in October, 1897, showed that it had extended outwards as far as  $30^{\circ}$ . There was still no central fixation; but the widening out of the temporal field of vision enabled the patient to more readily distinguish objects on the right hand, and consequently she had become less conscious of the degree of blindness which still existed.

## II. ACUTE NEURO-RETINITIS AFFECTING BOTH EYES, AND PROBABLY OF SYPHILITIC ORIGIN.

A tailor, twenty-five years of age, consulted me in May, 1893, on account of pain and loss of vision in the right eye. The blindness had lasted for several days, and was detected very soon after the onset of the pain, which was so severe that it had disturbed his sleep and incapacitated him for work. The eyelids were red and somewhat swollen, and there was injection of the larger bloodvessels beneath the ocular conjunc-

tiva. There was not, however, any sign of inflammation of the iris, and the intra-ocular tension was normal. The loss of vision was so complete that when the left eye was closed the patient was unable to distinguish light from darkness. On ophthalmoscopic examination the optic disc was seen to be enlarged, swollen, and prominent, and its outlines were ill-defined. The retinal bloodvessels were dilated and tortuous, but no haemorrhages were visible, although in the macular region there was a very peculiar exudation. In the left eye ophthalmoscopic examination revealed the existence of a mild neuroretinitis, but the vision of this eye was, when tested by Snellen's types, found to be quite up to the normal standard. Fomentations, leeches, and other local remedies were applied to relieve the excessive pain, and as there was a clear history of syphilis, calomel and opium pills and iodide of potassium were administered, and continued in doses sufficient to keep the patient gently under the influence of the mercurial. At the end of six weeks the pain was practically gone, but the sight of the right eye had not improved in the slightest degree, though the ophthalmoscopic appearances had changed considerably. The optic disc was still swollen and woolly, but atrophic changes were now seen to be commencing, and although the veins remained large and tortuous, the calibre of the arteries had become somewhat reduced. The exudation in the vicinity of the macula had almost wholly disappeared, its remains being represented by a greyish line which formed a circle with the macula as its centre. In the macula itself there was a peculiar disturbance of pigmentation, and a collection of numerous small glistening dots, which in less number were also scattered over the whole fundus, and which had the appearance characteristic of cholestearine crystals (Fig. 2). The left optic disc was still somewhat blurred, but the bloodvessels appeared normal, and there was no impairment of vision. The patient left the hospital soon after, and was next seen in the beginning of 1894, when he again consulted me, because his eyesight was becoming rapidly worse. He admitted that he had taken his medicines very irregularly. The right eye was quite blind, and the vision of the left was reduced to one-third of the normal acuity, while there was also

slight contraction of the visual field. On ophthalmoscopic examination it was found that there was advanced atrophy of the right optic disc, the arteries were small, and in the macular region the disturbance in pigmentation, before mentioned, was more extensive, and the minute white glistening dots more numerous. A seton was inserted into the nape, and treatment by means of mercurials was pushed to the point of salivation, with the gratifying result that by the end of a month the vision had decidedly improved, and ophthalmoscopic examination showed that the inflammatory exudation in the neighbourhood of the optic disc was becoming absorbed. No change was discovered in the macular region of the left eye. The improvement in vision steadily continued, and by the beginning of July the visual acuity was nearly normal. The seton was now removed, but antispasmodic remedies were continued, as there was still some exudation at the upper and outer aspect of the optic disc. This patient was not seen again until the spring of 1897, when he told me that he had suffered no further relapses, and had been able to continue regularly at his employment. No change could then be detected in the right fundus oculi, but the inflammatory exudation had disappeared completely from the left optic disc except that the congenital cup was filled up, and consequently obscured the retinal vessels in this part of their course. The arteries were normal in size, but the veins were still large and unnaturally tortuous.

### III. SUBRETINAL HAEMORRHAGE.

In the autumn of 1894 a woman about twenty years of age consulted me on account of blindness in the left eye, which had come on suddenly four weeks before. She told me that her health had been by no means good for some months, but that when she first experienced this loss of sight she had just returned from a holiday, and felt much stronger than usual. She said she was sure that, when she retired to bed, she saw equally well with either eye, but when she awoke in the morning she discovered that she could not see towards her left side, and when she closed her right eye she found that she was blind. She had no pain, but complained of a sense

of tightness in the left eyeball. It was thought by the ophthalmic surgeon, who examined the eye shortly after the onset, that the patient was suffering from embolism or thrombosis of the retinal vessels. By the time she consulted me there was a slight return of vision, and by excentric fixation she could count fingers. The pupils were of equal size, and actively responded both to the stimulus of light and in the act of convergence. The tension of the left eyeball was however reduced, and just below the macular region the retina had become separated, and was seen as a yellowish-grey opacity somewhat elevated above the level of the surrounding fundus, and traversed by small bloodvessels. The optic disc was acutely inflamed, and the surrounding retina was very oedematous, while inside this the fundus presented a very vividly red colour, as if the choroid was greatly congested. By degrees the neuro-retinitis subsided and the retinal detachment became less, and consequently there was steady improvement in sight. The patient now began, however, to complain that any object she saw with her left eye appeared crooked, and it was not until October, 1895, that this metamorphopsia wholly disappeared. The ophthalmoscope showed that the optic disc was at this time normal, but below the macula there was a yellowish-white patch of irregular outline and with deeply pigmented borders, due to atrophy of the choroid. Although the eyesight had improved so much the patient's general health had been all along most unsatisfactory. She was very anaemic, and her strength was much reduced by constantly recurring crops of "boils." From the autumn of 1895 till July, 1896, she suffered no inconvenience from either eye, and the vision of the left remained quite normal. On the 25th of that month, however, she became again conscious, in awaking from sleep, of the tight feeling in the eyeball, which had been experienced when the eye first became affected, and she found besides that her sight was dim and, as she described it, "everything had a pale green appearance." By the next day she was quite unable to see an object when she looked straight at it with the left eye alone, although there was still power to distinguish large objects to her left-hand side. There was no pain in the eye but a constant feeling of discomfort, and there were



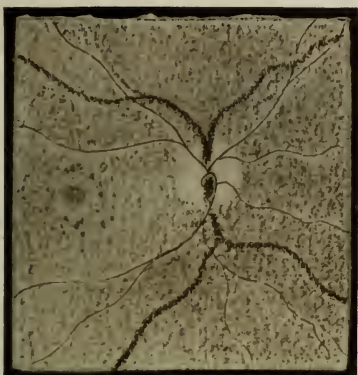


FIG. 1. EMBOLISM OF CENTRAL ARTERY OF THE RETINA.



FIG. 2. ACUTE NEURO-RETINITIS OF SYPHILITIC ORIGIN.



FIG. 3. SUBRETINAL HAEMORRHAGE.



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troublesome muscae volitantes. The pupil was active but slightly dilated, and the tension was reduced. The ophthalmoscope revealed evidence of haemorrhage around the patch of atrophied choroid already described as the seat of the former attack. Above this, involving the macula and a considerable area on every side of it, there was detachment of the retina, and as before both the optic disc and the surrounding structures were acutely inflamed (Fig. 3). The patient on this occasion often complained of pain in the eye, and was glad to wear dark glasses in order to protect it from the light. By the end of the year excentric vision had markedly improved, but central fixation was completely lost; and this was explained by the ophthalmoscopic picture, which showed that while the neuro-retinitis had passed away the site of the separation of the retina was mapped out by an area of atrophied choroid which was continuous with the patch due to the former attack. The patient's general health, however, had now begun to improve; and although central vision is irrecoverably lost in the left eye, sight seems to be improving in the peripheral parts of the field to such an extent that the sense of blindness, which was at first so marked, is now gradually passing away.

## THE OPHTHALMOSCOPE IN MEDICAL PRACTICE.

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THE importance of a careful examination of the eye with the ophthalmoscope as a part of the routine examination in all cases of doubtful diagnosis is not yet sufficiently appreciated. In all such cases a careful examination of the patient's various organs, his heart, lungs, liver, etc., is made as a matter of routine even in the absence of any special symptoms pointing to affection of these particular organs, and precisely the same rule should guide us with regard to the ophthalmoscopic examination of the eye. The value of ophthalmoscopic signs as an aid to medical diagnosis is universally known, and hence an ophthalmoscopic examination is usually made when the patient complains of any visual defect. But that pathological changes may be present in the fundus of the eye, without there being any great interference with central visual acuity, and hence without the patient being conscious of any visual defect, is a clinical fact not sufficiently well known. Nor is this so much to be wondered at, when we consider that the student's ophthalmoscopic training is nearly always acquired at an Eye Hospital, where patients never present themselves unless there is some decided visual defect. The knowledge of ophthalmoscopic changes apart from any conscious visual defect on the part of the patient can only be acquired by the constant use of the ophthalmoscope in the wards of a general hospital or in the daily work of private practice. It is surprising what extensive changes may be present in the eye, without the

patient being conscious of any marked interference with the function of vision. Optic neuritis, choroiditis, albuminuric retinitis, retinal haemorrhages, and other such changes may be present and yet the patient make no complaint about vision. No doubt if a careful examination of such cases is made some change in the visual acuity or visual fields will be discovered, but the change has been so slight that the patient is not conscious of it. This is particularly true of changes confined to the periphery of the fundus. If the macular region is unaffected, it is remarkable what extensive pathological changes may exist towards the periphery of the fundus, without any complaint on the part of the patient as to interference with the function of vision. Hence the physician, who makes it a regular practice to examine ophthalmoscopically every case of doubtful diagnosis, even when there is no complaint regarding vision, will frequently be rewarded by discovering at the fundus of the eye pathological changes, which may furnish him with the necessary additional data for a diagnosis and which may even form the only unequivocal sign of disease.

With a little practice the ophthalmoscopic examination can be made at the bedside with as great ease as the stethoscopic examination. The great value of the direct method in making such examinations cannot be too strongly insisted upon. From the increased magnification, details and slight changes in the condition of the fundus are easily recognizable, which would probably escape observation if the examination had been made by the indirect method alone. To the beginner the direct method of examination presents much greater difficulties than the indirect; a little steady perseverance, however, will soon smooth away the difficulties, and with increasing experience he will rely more and more upon it alone.

Another point to be impressed upon the inexperienced is that a dark room is not necessary for making successful ophthalmoscopic examinations. Certainly such examinations can be made with greatest comfort in the dark room, but they can be made also at the bedside. If the patient is able to sit up in bed this is done very easily, and with a little practice a successful ophthalmoscopic examination can be made even with the patient's head resting on the pillow. In the case of un-



conscious and delirious patients, it is of great importance to be able to examine the patient in this position. In short, with practice there are few cases indeed where an ophthalmoscopic examination is not practicable even under the most unfavourable circumstances.

With regard to illumination, the room may be darkened by pulling down the blinds, and if this is not sufficient, I have often found it of the greatest service to exclude the light by an assistant holding an open umbrella over the head of the examiner. If there is no draught to make the light unsteady, a candle or taper will be found quite sufficient to get a clear view of the fundus with the direct method.

With regard to mydriatics, the greater the experience of the examiner, the less will he require to use them. Still there are many cases where their use is absolutely necessary. A drop of 2 per cent. solution of cocaine will dilate the pupil slightly with the great advantage of leaving the ciliary muscle and accommodation unaffected, or if still greater dilatation is desired a drop or two of homatropine solution (four grs. to one ounce) will affect the object, and the resulting paralysis of accommodation will remain only from twelve to twenty-four hours. Atropine should never be used for mere purposes of examination as the resulting paralysis of accommodation may persist from seven to ten days afterwards.

Having made the ophthalmoscopic examination of the eye a regular part of every routine examination, both in hospital and private work, during the whole of my professional life, the value of such a practice has been increasingly manifest to me. It therefore occurred to me that a few observations based on experience over a wide field of hospital and private practice might prove of some use and interest to others.

There is no intention here of traversing the whole field of medical ophthalmoscopy, which is too extensive a subject to be dealt with in the limits of a single paper. I have selected the groups of cases in which ophthalmoscopic signs are most frequently met with, viz. intracranial growths, cerebral meningitis, locomotor ataxia, and other forms of disease of the spinal cord, Bright's disease of the kidneys, and pernicious anaemia. Through the kindness of Professor McCall Anderson

TABLE OF CASES EXAMINED IN  
PROF. M'CALL ANDERSON'S WARDS, 1892 TO 1897.

Disease.	Total number examined.	Number in which ophthalmoscopic changes were present.	Nature of Change.
Intracranial growths, -	18	10	9 cases : double optic neuritis. 1 case : optic atrophy, post-papillitic.
Cerebral meningitis, -	6	3	2 cases : double optic neuritis. 1 case : hyperaemia of discs with distension of veins.
Disseminated sclerosis,	12	2	2 cases : optic atrophy.
Locomotor ataxia, -	14	5	4 cases : optic atrophy. 1 case : hyperaemia of the discs.
Other forms of disease of the spinal cord,	22	2	Spinal meningitis : 1 case of optic neuritis. Syphilitic myelitis : 1 case of optic neuritis.
Bright's disease, chronic,	33	5	4 cases : neuro-retinitis with white spots and haemorrhage. 1 case : neuro-retinitis alone.
Bright's disease, acute,	32	2	2 cases : neuro-retinitis without white spots ; in one, numerous haemorrhages and subsequent death ; in the other, recovery.
Pernicious anaemia, -	4	4	2 cases : multiple retinal haemorrhage alone. 2 cases : multiple retinal haemorrhages with whitespots.
	141	33	

I am able to utilize the reports in his ward journals of the ophthalmoscopic examinations made by me in the wards during the last five years. The preceding table shows the number of cases examined in these different groups and also the number

of cases in which ophthalmoscopic changes were found. It will there be seen that out of a total of a hundred and forty-one cases examined ophthalmoscopic changes were found to be present in thirty-three. This must not be regarded as any indication of the usual proportion of fundus changes met with in the routine of medical practice. These groups have been selected as of special interest from the very great frequency of ophthalmoscopic signs. In many of the more common forms of disease ophthalmoscopic changes are rare. For example, in the hundreds of cardiac cases which I have examined, apart from pulsation of the retinal arteries frequently seen in valvular disease, I have only twice met with ophthalmoscopic signs directly connected with cardiac disease, viz. two cases of embolism of the retinal artery.

Let us take these groups and briefly review the results of clinical experience regarding the ophthalmoscopic signs in each.

Of the twenty-four cerebral cases examined, eighteen were cases of tumour, and in ten of these ophthalmoscopic changes were present. In nine cases the ophthalmoscopic sign was double optic neuritis of a very intense character. The neuritis was generally characterized by great swelling of the disc, complete obscuration of the edges, narrowing of the arteries, with distension and tortuosity of the veins. The vessels were here and there concealed by the swollen nerve tissue, or by exudation. Haemorrhages were frequent, and more commonly situated on the edge rather than on the surface of the swollen disc. Double optic neuritis, generally of this intense character, is a very valuable sign of intracranial tumour, because of the great frequency with which it occurs at some period in the progress of such cases. Our statistics illustrate to some extent the frequency of the conjunction of double optic neuritis with intracranial tumour, it being or having been present in ten out of the eighteen cases examined. Most statistics give a much more frequent occurrence of optic neuritis. Gowers says that in his own experience neuritis occurs in about four-fifths of the cases of cerebral tumour. The neuritis may occur at any period, and often does not occur until late in the history of such cases. All these

eighteen cases could not be kept under continuous observation, as many of them left the hospital, and it is highly probable that, could each case have been watched to its termination, a still larger proportion of cases with optic neuritis would have been recorded.

The optic neuritis is met with in tumours of all kinds, and in all positions within the cranium. In one of these cases the tumour was in the frontal lobe, in two others in the cerebellum, and in a fourth at the base of the brain. There is no special period at which the optic neuritis appears during the growth of the tumour, but as a rule it is not an early symptom.

There are exceptions to this, however, and it should be borne in mind that sometimes optic neuritis may be amongst the very earliest symptoms of intracranial tumour. The most striking example of this in my experience was a case seen about two years ago at the dispensary of the Western Infirmary. The patient was a man, apparently in robust health, who had been greatly troubled with giddiness, which had become so bad that he had to give up work and seek advice at the infirmary. The giddiness, or rather unsteadiness, was of a peculiar type with a great tendency to fall backwards. On cross-questioning him, he mentioned that his eyesight had been somewhat affected since the giddiness began. On ophthalmoscopic examination he was found to have optic neuritis of the intense type, with greatly swollen disc, haemorrhages, and exudations, the form commonly associated with cerebral tumour. There were no other symptoms, subjective or objective, to be made out on the most careful examination. The occurrence of the optic neuritis made it at once apparent that the giddiness was probably due to intracranial organic disease, and from the character of the neuritis, most probably to a tumour. The patient died in the Western Infirmary about six months afterwards, and at the autopsy a cerebellar tumour was found. Such an early appearance of optic neuritis is in my experience exceptional, still it is important to know that it does occasionally occur. Professor Max Knies reports a similar case, where double optic neuritis was one of the very earliest symptoms in a patient who, after death, was found to have a tumour of the cerebellum.

In one of eighteen cases of cerebral tumour examined, double



optic atrophy was found to be present. From the appearances it was evident that the atrophy followed a previous neuritis. It was therefore not a primary but a secondary or consecutive atrophy. This is an important clinical fact, which is apt to be overlooked by the inexperienced, that optic neuritis is a transient condition, and that when the patient comes under the notice of the physician the neuritis may be in the stage of retrogression, or may have actually passed into atrophy, the so-called post-papillitic or consecutive atrophy. This form of atrophy generally presents certain characteristic appearances which distinguish it from primary atrophy. The disc, though pale, has a filled-up appearance; the arteries are often smaller than normal in calibre, with white lines accompanying them, and the edges of the disc are frequently somewhat irregular, with disturbance of the pigment in their neighbourhood. In one of the nine cases of optic neuritis observed in the wards, the disc passed through all the stages from an acute optic neuritis of the intense type to a post-papillitic atrophy, during the patient's residence in hospital.

Of the six cases of cerebral meningitis examined, ophthalmoscopic changes were found in three. In two of these there was double optic neuritis, but of a very mild type, without much swelling of the papilla, and without the presence of haemorrhages or exudation. This mild form of neuritis is a marked contrast to the intense form with greatly swollen disc, haemorrhages, and exudations commonly met with in cases of cerebral tumour. In the third case there was hyperaemia of the disc, with distension and tortuosity of the veins. The importance of hyperaemia of the disc and distension of the veins as an aid to the early diagnosis of meningitis is, according to my experience, very considerable, and is certainly not generally known. The colour of the optic discs in conditions of health is very variable, and there is no strictly normal standard. In one patient the discs may be very pale, and in another distinctly pinkish, and yet this may be the normal character of each. When the hyperaemia is slight its pathological character can be recognized only by the fact of its having developed under observation. In all cases of suspected meningitis the discs ought to be watched carefully from day to

day as a part of the routine observation of the patient. If the discs are observed to become more hyperaemic, as evidenced by the increased redness or by the fact that a large number of previously invisible little vessels become visible upon the disc, then this is a sign of great significance, and particularly if this hyperaemia of the disc is accompanied by distension of the retinal veins. Hyperaemia of the discs and neuritis are much more frequent accompaniments of meningitis at the base than at the vertex, and hence these symptoms are met with most frequently in tubercular meningitis. The hyperaemia may be the first stage of a neuritis, but sometimes no neuritis develops. In these latter cases it is probably due to pressure of the basal effusion on the cavernous sinuses thus retarding the return of the blood from the discs, and leading to the hyperaemia and venous distension.

In nine cases of meningitis in private practice the discs have been watched carefully by me. In five of these cases at an early period hyperaemia with venous distension was observed, which in three developed into optic neuritis. Every physician of experience is well aware of the difficulties of early diagnosis in many cases of tubercular meningitis. I would insist in all suspected cases on a daily ophthalmoscopic examination of the fundus. The appearance of decided hyperaemia with venous distension will frequently be a valuable aid in enabling the physician to arrive at an early diagnosis. This hyperaemia may pass gradually into a neuritis, or may not. Taking hospital and private cases together, out of fifteen cases examined, optic neuritis was present in five, and hyperaemia of the discs with distension of the veins in three. Although in many cases of meningitis the neuritis does not manifest itself until the disease is well advanced and the diagnosis has already been established, still there are frequently cases where it is the earliest unequivocal sign of intracranial disease, and hence is of prime importance in the early settlement of the diagnosis. Hyperaemia of the discs with distension of the veins is often an early sign, and I think sufficient value has not been attached to this as a sign of intracranial disease. It is met with not only in tumour and meningitis, but in various pathological conditions, giving rise to increase of intracranial

pressure. As an example of its occurrence in other conditions, I will briefly quote two private cases—one of cerebral abscess, and the other of hydrocephalus.

In a case of cerebral abscess seen recently, the hyperaemia of the disc and venous distension gave great assistance in the early diagnosis.

A child, aet. eleven years, had been suffering from chronic suppurating ears for some time. Then headache with rise of temperature supervened. The optic discs were being duly watched, when the disc on the left side was observed to become markedly hyperaemic with great venous distension. A cautious prognosis was therefore given, although the other symptoms were improving. Three days after this, marked hyperaemia of the left disc was observed, the child had a series of severe convulsions either confined to the right arm and the right side of face, or, when general, always beginning with the right arm and right side of the face. The day after the convulsions both discs were hyperaemic with venous distension. The child was ultimately operated upon successfully by Prof. Macewen, and an abscess was found in the left temporo-sphenoidal lobe. An interesting point was the appearance of the hyperaemia of the left disc several days before that of the right, pointing to increase of pressure on the left side of the brain, of which we had unmistakable proof a few days later in the appearance of the convulsions confined to or beginning on the right side.

A case seen recently in consultation affords a further example of the value of hyperaemia of the discs with venous distension as a sign of increase of intracranial pressure.

The patient, a young lady, aet. eighteen years, when seen was comatose. There was a history of intermittent headaches for about a year previously, and of recent jaundice, from which she was recovering, when she was seized with gradually increasing drowsiness, which had rapidly deepened into coma. On ophthalmoscopic examination, the optic discs were found to be intensely hyperaemic, and the veins were greatly distended and tortuous. The hyperaemia and venous distension were equally intense in both eyes. The opinion given, based on the ophthalmoscopic examination, was that the coma was due to

increase of intracranial pressure, and from its rapid development probably pressure of a fluid nature. The patient died a few days afterwards, and on post-mortem examination there was found evidence of chronic hydrocephalus with excess of fluid in the ventricles and flattening of the convolutions.

In twelve cases of disseminated sclerosis examined, atrophy of the optic nerve was found to be present in two. Next to tabes, this is the nervous disease which is most frequently associated with primary optic atrophy. It used to be generally taught that optic atrophy occurred only very rarely in disseminated sclerosis. Buzzard several years ago called attention to the fact that clinical experience, on the contrary, showed that optic atrophy was found to occur in disseminated sclerosis with considerable frequency. My own experience is in harmony with that of Buzzard, and that out of twelve consecutive cases examined in the Western Infirmary, two should exhibit optic atrophy, is only a confirmation of my experience elsewhere. Specially important is the fact that the optic atrophy is frequently a very early symptom, and may first direct attention to the grave disease from which the patient is suffering, but of which the other symptoms are so slight that their true character has been unsuspected. I have seen at the Eye Infirmary a considerable number of cases where the optic atrophy associated with increasing weakness of the lower limbs and greatly exaggerated knee jerks, led to the diagnosis of atrophy dependant upon degenerative disease of the spinal cord, probably incipient disseminated sclerosis. In some of these cases kept under observation, the further development of other symptoms confirmed the diagnosis.

Out of thirty-six cases of disease of the spinal cord, ophthalmoscopic changes at the fundus were found in seven.

Fourteen cases of locomotor ataxia were examined, and atrophy of the optic nerves was found to be present in four. Of all the diseases of the cord, locomotor ataxia is that most frequently associated with ophthalmoscopic changes, viz. optic atrophy. It is very difficult to say with what degree of frequency these changes occur, and statistics vary greatly. Gowers, in his *Medical Ophthalmoscopy*, says that out of thirty consecutive cases observed by him, only three presented optic nerve



atrophy, and from these cases and other experience, he does not think that optic nerve atrophy occurs in more than 15 per cent. of ataxics. Leber estimates its frequency at 26 per cent., Berger at 33 per cent., and Uhthoff at 20 per cent. My fourteen cases form too narrow a basis to found reliable statistics on, however, they give nearly 28 per cent. The statistics of the ophthalmologists furnish a much higher percentage than those of the neurologists. While opinions differ as to its exact frequency, all are agreed that it is a very frequent symptom in locomotor ataxia, and, what is more important from the diagnostic point of view, that it very frequently is a very early symptom, and may sometimes even be the very first symptom. It is by far the commonest cause of optic atrophy. According to Galezowski, about two-thirds of all optic nerve atrophies are tabetic. I have always made it a routine practice at the Eye Infirmary, and in private, to carefully test the reflexes of every patient with optic atrophy, and have been struck with the great frequency with which the knee jerks are diminished or entirely absent. In many of these no other signs of tabes were present, but clinical experience teaches that in these cases with early atrophy the progress of the spinal disease is very slow. This occurs with such frequency that it may be said that every case of primary optic atrophy should raise a strong suspicion of tabes, and that the patient's reflexes should be very carefully examined. If this is done habitually, it will frequently lead to the discovery of incipient locomotor ataxia, which had previously been unsuspected.

In one of the fourteen cases of locomotor ataxia examined there was well marked hyperaemia in both optic discs with slight obscuration of the edges. According to Allbutt, in tabes the optic atrophy is preceded by hyperaemia of the discs with slight obscuration of the edges, but these symptoms never go on to optic neuritis. This patient was not under observation for a sufficient time for the subsequent development of the atrophy to be seen, but it is highly probable that the hyperaemia of the discs was the initial stage of atrophy, as described by Allbutt.

In other diseases of the spinal cord or its membranes, ophthalmoscopic signs are not very frequent. Out of

twenty-two cases examined, changes at the fundus were found in two. Double optic neuritis of a mild type was found in a case of spinal meningitis, and also in a case of syphilitic myelitis. Optic neuritis, however, is so rarely associated with these conditions as to be of very little value from the diagnostic point of view.

Out of sixty-five cases of Bright's disease examined, ophthalmoscopic changes were found in seven. Here too there is a great discrepancy in the statistics as to the frequency of retinal changes given by different writers. This varies from seven to thirty per cent. According to Professor Knies the lower figure is probably nearer the truth. Our statistics give retinal changes present in about eleven per cent. of the cases, and this is probably a fair approximate to the actual frequency.

The fundus change generally met with in the chronic and subacute cases of Bright's disease is a double neuro-retinitis. The characteristic neuro-retinitis albuminurica is distinguished by two features, viz. white patches and haemorrhages, which may either be combined or occur separately. More frequently they are both present. The white patches of various shapes and sizes scattered irregularly over the fundus are very frequently grouped in a stellate form round the macula.

Out of thirty-three cases of chronic Bright's disease, neuro-retinitis was found to be present in five. It was of the typical albuminuric type, with white spots and haemorrhages in four cases, but there was one case in which neither spots nor haemorrhages were present but simply a mild neuro-retinitis. Hence in all cases of neuro-retinitis the urine should be examined for albumen even in the absence of white spots and haemorrhages. From the diagnostic point of view the detection of neuro-retinitis albuminurica is frequently of the greatest importance, as it is so often a very early symptom, and leads directly to the discovery of therenal disease, which may have hitherto been quite unsuspected by the patient. Chronic Bright's disease is generally very slow and insidious in its onset. It may have been present for a considerable time, and yet have given rise only to vague general symptoms such as headache, malaise, digestive disturbances, or a feeling of weakness. The occurrence of neuro-retinitis and consequent failure

of vision causes the patient to seek advice. The ophthalmoscopic appearances lead to the examination of the urine, when the true character of the disease is discovered. This is a familiar experience. In a large proportion of the cases of albuminuric retinitis presenting themselves at the Eye Infirmary, the renal disease has been quite unsuspected, and the diagnosis is first made from the fundus appearances.

From the point of view of prognosis, the recognition of albuminuric retinitis is of some importance. But here a distinction must be made between chronic and acute Bright's disease. Retinitis and neuro-retinitis, although occurring most frequently in the chronic forms of renal disease and particularly in interstitial nephritis, are met with in the acute and subacute forms of nephritis. These conditions occurring in chronic Bright's disease are always symptoms of grave prognostic significance. It is a matter of general agreement that in such cases life is rarely prolonged longer than one year, at the most two years after the discovery of the retinal affection. Fundus changes are also met with in the acute form. Out of thirty-two cases of acute Bright's disease examined, fundus changes were found in two. This is a much smaller percentage than in the chronic forms. In these two cases there was a double neuro-retinitis, but without the characteristic white spots. In one case there were very numerous haemorrhages scattered all over the fundus. This case was noticeable in that the haemorrhagic neuro-retinitis developed during the stay of the patient in hospital. The fundus was examined shortly after admission and found to be normal. The patient died of oedema of lungs and larynx nine days after the discovery of the haemorrhagic neuro-retinitis.

This case supports the view expressed by some as to the particularly grave prognosis associated with the haemorrhagic form of neuro-retinitis.

In the other case of acute nephritis, the neuro-retinitis of a very mild type gradually subsided with the progressive disappearance of albumen from the urine. Recovery in the acute and subacute forms is by no means rare, the retinitis gradually subsiding with the disappearance of the albumen. This favourable termination is seen most frequently in the retinitis

met with in the albuminuria of pregnancy, where the albuminuria is generally transitory, disappearing after the birth of the child. I have reported in the *British Medical Journal* of 8th May, 1897, a complete recovery from albuminuric retinitis of typical form with white spots and haemorrhages, in a case of acute parenchymatous nephritis, the retinitis gradually disappearing with the albumen, until both fundus and urine were normal.

Clinical experience thus teaches that in albuminuric retinitis the prognosis must largely depend upon the character of the renal affection. If it occurs in the course of a chronic interstitial nephritis the prognosis is exceedingly grave, and the probability of the patient surviving beyond a couple of years is very slight; but if it occurs in the course of an acute or sub-acute parenchymatous nephritis, with careful treatment and under favourable hygienic conditions, there is considerable hope that the patient may recover from the renal condition and that the retinitis may disappear, leaving the patient sometimes with vision but little impaired. Hence in every case of albuminuric retinitis, before expressing an opinion as to prognosis, it is of great importance to ascertain by careful consideration of the history and examination of the urine the character of the renal affection.

In progressive pernicious anaemia the ophthalmoscopic signs are most important from the point of view of diagnosis. I have examined in the Western Infirmary four cases of pernicious anaemia, and in every case multiple retinal haemorrhages were found. Two were males and two females, and all had a fatal termination. This experience confirms that of other observers. One of the characteristic features of pernicious anaemia is a tendency to haemorrhage, but it is not sufficiently well known that haemorrhages occur more frequently in the retina than elsewhere, and hence form a most valuable aid to diagnosis. Of sixteen cases examined by Quincke, retinal haemorrhages were absent in one only. In thirty cases examined by Horner, extravasations were present almost without exception. Retinal haemorrhage is therefore one of the most constant symptoms of this disease. The haemorrhages are nearly always multiple and in both eyes. In the four cases examined this was so. These retinal haemor-



rhages, generally pretty numerous, are of varied sizes and shapes. They are usually most abundant round the optic nerve entrance, and are more or less flame-shaped, from their situation in the layer of nerve fibres. They are frequently, but not always, associated with white spots and areas, which according to many are due in part to leucocyte-like cells, and in part to degeneration of the retinal tissues. In two of the four cases these white spots were seen, but in the other two haemorrhages alone were present. As a rule there is no conscious defect of vision unless extravasation takes place into the macular region. In one case the patient complained of misty red vision in one eye, and on examination a large recent haemorrhage was seen near the macular region, but in none of the others was there any complaint about vision. The eyes were examined as part of the routine examination. In the very large number of cases of anaemia and chlorosis examined by me, I have never seen multiple retinal haemorrhages such as are almost constantly met with in progressive pernicious anaemia. I have seen slight optic neuritis and single large haemorrhages in these conditions, but this could not be confused with the multiple retinal haemorrhages of pernicious anaemia. It should be remembered, however, that in leukaemia sometimes a leukaemic retinitis is met with, in which retinal haemorrhages and white spots form a prominent feature. But the other symptoms easily differentiate it from pernicious anaemia.

In the diseases mentioned in the preceding pages, ophthalmoscopic signs are of very frequent occurrence, and hence in these conditions are often of great importance as an aid to diagnosis. In many other diseases, however, ophthalmoscopic changes, though comparatively rare, may sometimes give considerable help in diagnosis, and may actually lead to the diagnosis of a disease previously unsuspected.

In valvular diseases of the heart ophthalmoscopic changes are very rare, with the exception of pulsation of the retinal arteries frequently visible in cases of valvular disease, and particularly frequent in aortic regurgitation. On two occasions, however, in my experience, the recognition of embolism of the retinal artery led directly to the diagnosis of valvular disease of the heart.

The first case was that of a woman, aet. forty-five, suffering from bronchitis, who, while in the waiting-room of the Western Infirmary, after a fit of coughing, suddenly lost the sight of the right eye. She was seen on the following day in the wards, and on ophthalmoscopic examination it was evident that the loss of vision was due to embolism of one of the main lateral branches of the central artery of the retina. The embolus could be seen as a dark-red swelling plugging the main lateral branch supplying the macular region, and beyond it the vessel was reduced to a mere thread. The retina showed a diffuse greyish opacity round the macular region, with the macula clearly showing as a bright cherry-red spot. These appearances were especially characteristic. On examining her heart, a systolic murmur was heard at the apex, but the patient herself was not aware that she had heart disease. On examining this patient a year afterwards, it was found that with the right eye she could only see large objects somewhat indistinctly in the peripheral parts of the field. On ophthalmoscopic examination the disc presented all the appearances of optic atrophy. It was silvery white, with clean cut edges, and the branches of the retinal artery supplying the macular region were reduced to mere threads.

The other case was that of a man, aet. fifty-eight, who presented himself at the Eye Infirmary with the history that on the preceding day he had suddenly lost the sight of his right eye. There was no complaint whatever about his general health. On ophthalmoscopic examination it was evident that the sudden failure of vision was due to embolism of the central artery of the retina, as evidenced by the pallor of the disc, the retinal arteries reduced to mere threads, and the bright cherry-red spot in the macular region, surrounded by the opaque greyish oedematous retina. On examining his heart there was a loud systolic murmur, best heard at the apex, which was displaced downwards and to the left.

In these two cases the ophthalmoscopic examination led directly to the discovery of cardiac disease. Embolism of the retinal artery is not a common affection, and unless it is seen within a few days of its occurrence, the typical appearances will have disappeared, and the nature of the case can only be

inferred from the history. These two cases were examined within thirty-six hours of their occurrence. As a rule it takes several hours for the characteristic appearances caused by the opaque oedematous retina to develop, and in the course of a week or two these will have entirely disappeared. It is therefore possible to make the diagnosis with certainty only during a comparatively brief period. In the first case the fundus examined a year afterwards presented all the appearances of optic atrophy, and the true nature of the case could only have been inferred from the history of the sudden onset of the blindness, and from the great reduction in the calibre of the retinal arteries.

Whilst albuminuric retinitis is a condition which is more or less familiar to every one, there is a peculiar form of retinitis met with in diabetes mellitus, which is by no means so well known. This diabetic retinitis is a very rare affection as compared with the albuminuric form. It is, however, of great importance to be able to recognize it, as its recognition may first lead to the examination of the urine, and the discovery of the grave disease from which the patient is suffering. In a case recently seen by me, the recognition of the retinitis led directly to the diagnosis of diabetes mellitus previously unsuspected.

A lady, aet. fifty-two, consulted me recently about gradual failure of vision in both eyes. On examination, a retinitis of a peculiar type was seen. Numerous brilliant white spots were scattered over the fundus, most abundantly between the macula and the optic nerve. They varied greatly in size, some being very large, obscuring the retinal vessels, and others mere rounded points. A few small haemorrhages were to be seen near the vessels. The appearances differed from those of albuminuric retinitis in two respects. (1) There was no radiate arrangement of white spots in the peri-macular region; and (2) there was no neuritis, the optic nerve being quite normal. The patient expressed herself as not feeling very well during the last year. On examining her urine its specific gravity was found to be 1034, with a very minute trace of albumen but abundant sugar.

On further examination of the patient she admitted that

she had been somewhat thirsty of late, and had been passing a considerable quantity of urine.

It is generally taught that retinitis occurs in severe cases of diabetes, and in the late stages of the disease, and my previous experience was entirely in harmony with this. When this is so the diagnosis of diabetes has long since been made. The case reported, however, shows that there are exceptions to this as to most rules, and that retinitis may occur at a very early period in the course of the disease, and may first lead to its detection. According to Hirschberg, retinitis with haemorrhages and white patches is generally found in diabetes which has lasted more than ten to twelve years, and is a terminal symptom of the disease.

The case just recorded was first seen by me fourteen months ago, and the patient is still in fairly good health, the amount of sugar being kept in control by dietary. The retinitis remains practically the same. Hence in diabetes mellitus, although the occurrence of retinitis generally increases the gravity of the prognosis and points to an early fatal termination, there are exceptional cases where the retinitis occurs in mild cases and at an early stage of the disease.

The ophthalmoscope often gives the physician most valuable information as to the presence of syphilis. The surface of the body is always carefully examined in a suspected case for scars, cicatrices, and other indications of previous syphilitic affections, but the fundus of the eye is but rarely explored with a view to throwing light on the past history of the patient. Yet the fundus of the eye often supplies unmistakable evidence as to past syphilis, either acquired or congenital. Choroiditis and retino-choroiditis are frequent results of both acquired and congenital syphilis. These leave considerable traces on the fundus for the rest of the patient's life in the shape of atrophic patches surrounded by irregular accumulations of pigment. Very frequently the macular region entirely escapes, the disease having been confined to the peripheral parts of the fundus, hence the patient's central vision is good, and there is no complaint as to diminished visual acuity. If there is any suspicion of syphilis, acquired or congenital, the eyes ought always to be examined with the ophthalmoscope, although the external appearances



are normal and the patient's vision is good. The physician will frequently be rewarded by discovering at the fundus changes in retina and choroid, which give him invaluable information as to the past history of the patient.

The preceding pages amply support the proposition that in medical practice an ophthalmoscopic examination should be made a part of the routine examination of the patient, even where there is no complaint whatever as regards vision. It has been repeatedly pointed out in this paper that very extensive changes at the fundus may be found with little if any lessening of the central visual acuity, and hence without any consciousness of visual disturbance on the part of the patient. Too little attention has been paid to this aspect of ophthalmology, and hence its great importance as an aid to medical diagnosis is not sufficiently appreciated. A little practice will enable the observer to acquire the direct method of examination, and he will thus be in a position to examine ophthalmoscopically the ocular fundus with as great ease as he can examine the heart with his stethoscope.

A new field of examination is thus opened to him, in which he may see additional objective signs of disease, which will often be of the greatest service to him, sometimes by confirming the diagnosis already arrived at, sometimes by supplying the additional data requisite for a diagnosis, and sometimes even by affording the first objective signs of the general disease from which the patient may be suffering.

One thing is certain, that the greater the attention bestowed on the relationship between eye symptoms and general diseases, the greater will appear the advantages of the routine use of the ophthalmoscope in medical practice.

# A CASE OF BILATERAL PARALYSIS OF FACIAL AND AUDITORY NERVES,

WITH LEFT HEMIPLEGIA, IN THE SECONDARY STAGE  
OF SYPHILIS.

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DOUBLE facial paralysis is an uncommon condition, but its occurrence in the secondary stage of syphilis along with other nervous lesions is perhaps sufficient justification for a somewhat complete record of this case, especially as opportunities were afforded of investigating the pathological changes.

J. C——,<sup>1</sup> sailor, aged thirty-two, came first under observation at the Western Infirmary Dispensary on April 12th, 1894, and was admitted to Professor Gairdner's ward on the 17th. His main complaint was of the condition of his face, but he mentioned also a certain feeling of weakness in his legs. Apart from occasional attacks of rheumatic pains, never so severe as to cause him to take to bed, he had enjoyed good health up till June, 1893, when he suffered for a short time from a venereal sore. He was well again till November, when he had to go to hospital in New York on account of an eruption over his body, which soon disappeared under mercurial treatment. At the end of December he set sail from New York, and his ship on reaching another port in one of the Northern States was frozen in, necessitating a stay there till the 4th of March, 1894. During that stay several of his shipmates were frost-bitten, and he himself had a swelling of

<sup>1</sup> The clinical report is taken from notes by the late Dr. John H. Carslaw.

his neck. A few days after leaving port (and about nine months after primary syphilis) he was on duty at the wheel, a sharp wind blowing from his right, when he became conscious of a tingling of the right ear, and a feeling of numbness and of something unnatural about the right side of his face. On putting up his hand he found that the eye did not close on his making an effort to shut it. Within the next day or two he was conscious that a similar condition gradually developed on the left side, but it was only after both eyes were distinctly affected that he noticed anything unusual about the mouth, speech and the taking of food becoming difficult. After the numbness passed off, pain was felt in both parotid regions and over both cheeks. The weakness of the limbs was of later and of more gradual development. So far as he could tell, there had been no staggering, and he had no definite sense of giddiness. There was no headache or sickness. As regards his habits, it may be mentioned that he had for many years been in the habit of drinking to excess when ashore. But in the early part of the year his captain had allowed no alcohol to be served on board, and when they were frozen up he had not gone ashore for liquor, nor indulged in it at all. His father and mother both lived to old age, and neither they nor any other member of his family had been rheumatic.

The double facial paralysis was very complete, and at once attracted attention. There was entire absence of expression in the features. The effort to raise the eyebrows was without avail, and on his attempting to close the eyes the lids remained open and the sclerotics were exposed to view, the corneae disappearing as the eyeballs rolled upwards (Fig. 1). The lips could not by any effort be firmly closed, and whistling was impossible. He had considerable difficulty in feeding himself, and his speech, which was very defective, was found to err through his inability to pronounce the labials. The movements of the eyeballs, of the palate, and of the tongue were all normal. The pupils were equal, and reacted normally to light and on accommodation. Sensation was normal on both sides of the face, and the electrical examination of the facial nerves and muscles gave the reaction of degeneration on both sides. There was thus very marked loss of faradic irritability, and

while galvanic irritability of the nerves was lost, that of the muscles was distinctly increased. However, there was no serial change, *KCC* always preceding *ACC* and *AOC*; but, while testing, the contractions of the muscles were noticed to be exceedingly slow and long drawn out.

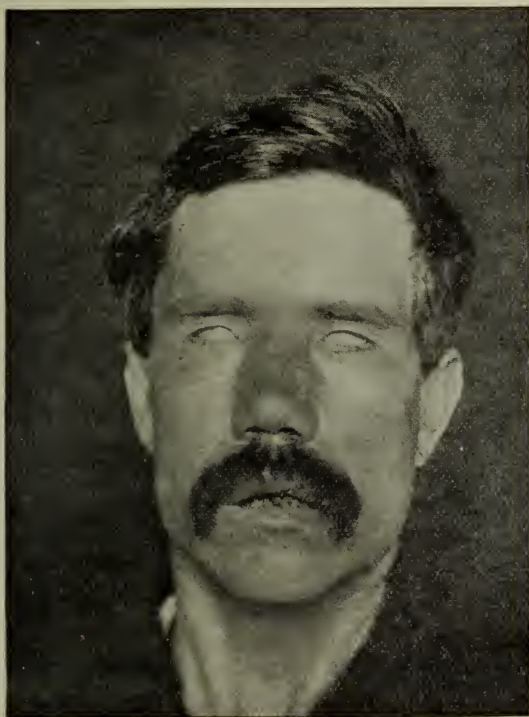


FIG. 1.—BILATERAL FACIAL PARALYSIS (attempting to close the eyes).  
 Photograph of J. C. by Dr. A. W. Russell.—April 19th, 1894.

He was not conscious of being deaf or of any unnatural noises in the ears, and never had had any discharge from his ears. But the result of testing his hearing with the watch was

$$R = \frac{P}{40}, L = \frac{2}{40},$$

while with the tuning-fork air conduction was in excess of bone conduction, from which Dr. Barr, who examined the patient, inferred that the source of the deafness was in the nervous apparatus. One or two attempts were



made to test the sense of taste, but without very satisfactory results. It may, however, be said that the sense of taste in the anterior part of the tongue was certainly not lost, though probably impaired, and no difference was detected between the two sides. The sense of smell was impaired, but probably from inability to sniff depending on the facial palsy. Examination of the arms and legs gave normal results as to touch, pain, temperature, and electricity. The dynamometer recorded 30 with the right hand and 28 with the left, and the power of the legs seemed fairly natural in spite of the patient's feeling of weakness. The deep reflexes were if anything slightly exaggerated, but there was no tendency to stiffness or spasm. The gait was certainly not very steady, and on the ward floor he required three planks to get along comfortably, but he himself said that he was not any more unsteady than he usually was when ashore. He could turn suddenly in walking without any staggering, and could stand quite steadily with his eyes shut and his heels together.

Physical examination of the chest and abdomen revealed nothing of any importance, and the urine contained neither sugar nor albumen. It should be added that on admission the patient had some slight superficial ulceration of the right tonsil, such as is met with in the secondary stage of syphilis.

The patient improved, both in general health and in regard to some of the special actions of the facial muscles, under antisyphilitic remedies and galvanism. But on May 26th, 1894 (*i.e.* within a year of the primary syphilis), he was found to have left hemiplegia, the left arm being quite powerless, and the left leg less deeply affected, and without sensory disturbance. An interesting point in regard to this hemiplegia was that at first the plantar and knee reflexes on the affected side were distinctly defective, whereas, nine days later, these reflexes were relatively excessive. Again, on June 4th, respiratory difficulty was noticed, with rise of temperature and pulse rate and physical signs of pneumonia, a pneumonia which post-mortem was found to be lobular and gangrenous, and probably caused by the passage of food or other foreign substance into the respiratory passages. In this connection a note in the Ward Journal a few days after the onset of the hemiplegia is

of interest, to the effect that "the task of feeding the patient is found to be a very difficult one." The patient died after eight days' acute illness.

Fortunately a post-mortem examination was permitted, and the most important facts made out are here summarized from a report by Professor Coats: Softening of right corpus striatum; lungs in the condition indicating lobular pneumonia with gangrene; heart normal; kidneys and other abdominal viscera normal. The left petrous bone was split open through the tympanum by Dr. Barr, and the course of the Fallopiian

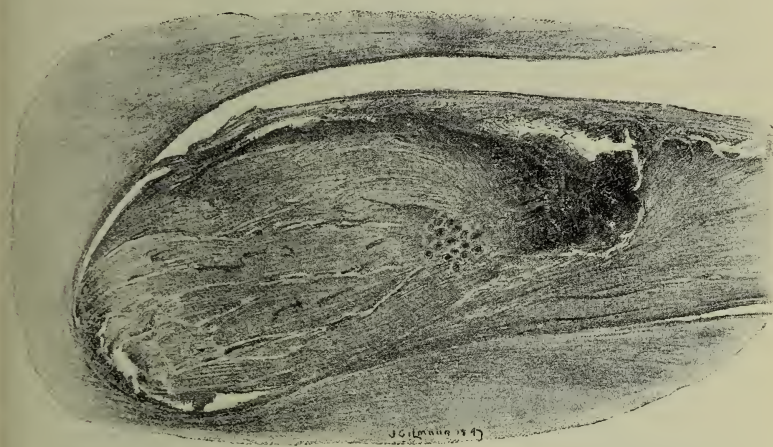


FIG. 2.—FACIAL NERVE IN THE AQUEDUCT OF FALLOPIUS AT THE GENU. Longitudinal section showing a large haemorrhage in the nerve, and a smaller one proximally; also engorged bloodvessels. Part of the geniculate ganglion is shown. (Low Power.)

canal traced out. Dr. Barr reported that "there was no evidence of middle ear disease of any kind, nor of any bony thickening, there being no encroachment on the capacity of the canal. The facial nerve in its course was somewhat thickened, and had a reddish appearance." The right petrous bone was decalcified, and its careful microscopical examination resulted in the discovery of important pathological conditions.<sup>1</sup> There were numerous small haemorrhages, mainly in and under the

<sup>1</sup>I am indebted to Dr. R. M. Buchanan for assistance in the microscopical examination.

sheaths of both the facial and the auditory nerves, compressing the nerves, but also in the substance of the nerves. The haemorrhages were present in the facial nerve in the upper part of its course through the petrous bone, the most distinct one being at the genu (Fig. 2). Besides the haemorrhages, seen in the course of the auditory nerve (Fig. 3), there were also similar small haemorrhages in the membranous cochlea. There was, in addition, apparently degeneration of

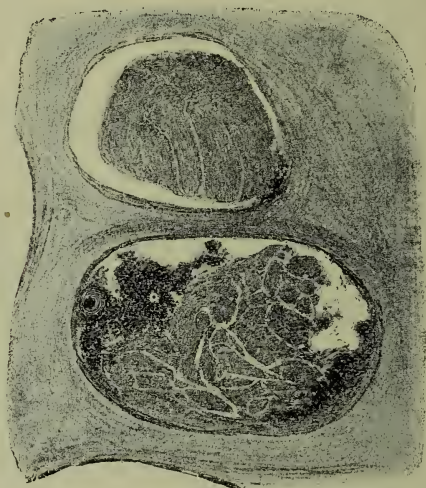


FIG. 3.—THE FACIAL AND AUDITORY NERVES at the outer end of the internal auditory meatus. The facial is slightly oblique, and shows a small haemorrhage. The auditory is transverse, and shows two distinct haemorrhages. (Low Power.)

the facial nerve. Unfortunately, however, the decalcifying process made it impossible to get the nerves stained satisfactorily by Weigert's method, so that the nerve degeneration was not well demonstrated. But specimens from the facial nerve, not far from its exit, showed distinct excess of connective tissue and diminution of nerve fibres. There was marked engorgement of the small bloodvessels of the nerves, and some of them had apparent thickening of the middle coat, and contents so dense and dark-coloured as to suggest thrombosis, but no cellular infiltration was detected. The examination of the brain in the softened area revealed certain localized proliferations of cells in the external coats of the bloodvessels, and also haemorrhages into the perivascular spaces. The vessels of the



pia mater also, examined in this neighbourhood, showed similar conditions of proliferation and haemorrhage, and at several points the cellular proliferation was also seen to extend a short distance into the brain substance. Sections were made of the medulla and pons for the purpose of examining the motor tracts, but these showed no appreciable descending degeneration by Weigert's method. In this connection, however, it should be noted that death occurred only seventeen days after the onset of hemiplegia.

During the patient's illness there was considerable difficulty in determining whether the double facial paralysis was to be regarded as of "rheumatic" (so-called) origin or of syphilitic origin. The patient had a history of previous rheumatic pains, and the onset of paralysis was sudden and distinctly connected in his own mind with exposure to a specially cold wind. Moreover, though simple rheumatic facial paralysis is usually unilateral, genuine cases of bilateral paralysis of the portio dura of this nature have been recorded.<sup>1</sup> However the co-existence of the bilateral nervous deafness, and the subsequent development of hemiplegia from still another nervous lesion indicated the probability of all the nervous symptoms being really syphilitic. The microscopical examination of the tissues has amply confirmed this view, for it demonstrated similar lesions in both the facial and auditory nerves and also in the brain, lesions depending on pathological changes in the smaller bloodvessels and probably characteristic of the secondary stage of syphilis.

It used to be taught that all the syphilitic affections of the nervous system came late in the disease, and were distinctly of the tertiary stage; and no doubt the tertiary period is the common one for such manifestations. Then the lesions are most probably of the gummatous nature, and the facial nerves might be implicated in such lesions, but almost certainly along with some other cranial nerves, and very unlikely both facials alone—still more unlikely only the facial and auditory nerves of both sides. We now know, however, that it is not at all

<sup>1</sup> Among others see an interesting case reported by Prof. Gairdner, *Lancet*, 1861, I. 477, *et seq.*; also a case by Dr. M'Donnell in *Medico-Chirurg. Transactions*, 1875, Vol. LVIII., 369-375.



infrequent for patients to suffer from affections of the cerebro-spinal system in the comparatively early stages of syphilis. At this time various functional disturbances are not uncommon, such as different forms of neuralgia, and sensory disturbances, especially analgesia, to which attention has been specially drawn by Fournier. There are also abundant clinical records of paralysis both central and peripheral occurring early. The tendency has been to regard these as early or precocious tertiary phenomena, but they probably belong as definitely to the secondary period as the skin eruptions or the affections of the throat, eyes, etc., and may be due to lesions similar to those demonstrated in the present case. Dr. Buzzard, in his *Clinical Aspects of Syphilitic Nervous Affections*,<sup>1</sup> discusses the question, quoting the experience of Lancereaux and other continental authorities. Two years ago (Feb. 26 and March 12, 1895), in the London Royal Medical and Chirurgical Society, an interesting discussion took place on this subject: "The affections of the nervous system occurring in the early stages of syphilis,"<sup>2</sup> in which many of the leading British neurologists took part. The general outcome of that discussion was the recognition of the fact that nervous complications of syphilis do occur in the truly secondary stage, and that these are probably dependent on changes in the smaller bloodvessels, not in the nervous elements themselves. Such early affections are as a rule not of serious prognosis, though on account of the destructive processes recovery may be only partial, and opportunity seldom occurs to make pathological examination. Some such examinations have however been reported with apparent absence of anatomical lesions,<sup>3</sup> but at the above discussion Mr. Jonathan Hutchinson related a fatal case of early syphilitic paraplegia, published by M. Lamy, of Paris,<sup>4</sup> in which microscopic changes were found in the spinal cord quite analogous to the changes found in the facial and auditory nerves, and the corpus striatum of the present case. "The stress of the disease had fallen on the perivascular spaces of the vessels, especially the veins, and had respected

<sup>1</sup> Buzzard, *Clinical Aspects of Syphilitic Nervous Affections*, pp. 43 et seq.

<sup>2</sup> See *British Medical Journal*, 1895, I., p. 476, etc.

<sup>3</sup> Heubner in Von Ziemssen's *Cyclopaedia*, Vol. XII., pp. 316, 344, 354.

<sup>4</sup> *B. M. J.*, 1895, I., p. 485.

the nervous elements. In the grey matter the perivascular spaces contained colloid matter; in places the veins were thrombosed, and showed microscopic gummata in connection with them. There was some degeneration running in from the pia mater, but most of the nerve elements were normal." Of similar cases of paraplegia, Mr. Jonathan Hutchinson has recorded<sup>1</sup> no less than twenty-one examples, occurring within the first two years after primary syphilis, and regarded by him as secondary. In other cases hemiplegia is the form the disease takes, as in our own case (within one year), and in cases quoted by Dr. Buzzard.<sup>2</sup> Occasionally there is the occurrence of paralysis of single nerves, it may be symmetrically or not. Of such local paralyses, Fournier<sup>3</sup> writes that "Much the most common is facial hemiplegia. Next in order of frequency comes paralysis of the third pair of nerves, which may be either complete or partial. That of the sixth pair is rarer. We may add that of these paralyses the earliest in appearance without the least doubt is facial hemiplegia. It has been observed repeatedly during the fourth, fifth, and sixth months after infection, and one has even seen it (but this is exceptional) along with the first secondary phenomena accompanying the roseola. The ocular paralyses are distinctly later in development." From similar causes, probably, nervous deafness may be rapidly produced at an early stage of acquired syphilis, though this form of deafness is more frequent in the so-called secondary stage of the inherited disease, accompanying interstitial keratitis.

Of these various nervous complications of secondary syphilis, not the least remarkable is the occasional and simultaneous affection of both the divisions of the seventh cranial nerve. These two nerves come into close relations in the temporal bone, and are exposed to similar conditions in passing through dense bony canals, and on this account pathological changes should be rapidly manifested by clinical symptoms. Cases of this kind may be symmetrical like the present, and their early occurrence would explain the symmetry, but that they may

<sup>1</sup> *Archives of Surgery*, Vol. VII., p. 233, etc. (July, 1896).

<sup>2</sup> *Syphilitic Nervous Affections* (Buzzard), p. 44.

<sup>3</sup> Fournier's *Leçons Cliniques sur La Syphilis étudiée plus particulièrement chez la Femme*. Edition, 1881, p. 611, with foot-note.

not be so is illustrated by a case which has recently occurred in the private practice of Dr. J. P. Boyd, of which he has given me the following details. This patient, a young man, contracted syphilis, which was followed by the ordinary secondary affections of the skin and throat. About five or six months after infection he suddenly developed unilateral facial paralysis and profound nervous deafness on the same side. Four months later he had a well-marked syphilitic orchitis, but he has had no new nervous symptoms. Under treatment the facial paralysis has considerably improved, but the nervous deafness remains much the same.

Cases of bilateral affection of both facial and auditory nerves in syphilis are rarely recorded, and in his interesting paper in *Guy's Hospital Reports*<sup>1</sup> on a case of this kind, Dr. Pye Smith has enumerated six examples. To this list, in addition to the present case, there may be added another which has a striking resemblance to it, and of which I have Dr. James Finlayson's kind permission to narrate some details. The patient, J. M., a discharged soldier, now (June, 1897), *act.* 25, was under Dr. Finlayson's care in the Western Infirmary, Glasgow, in the spring of 1895. His previous health had been good, except for the fact that for some years he had had some discharge from his right ear, though he had not thought he was dull of hearing on that side. In March, 1894, he contracted syphilis, and was in the military hospital under mercurial treatment for five months, during which he developed a bubo, sore throat, skin eruption, and alopecia. At the end of August, 1894 (*i.e.* within six months), he suddenly developed bi-facial paralysis and bilateral deafness, with marked tinnitus and also vertigo. The facial paralysis was well marked though not complete, and R.D. was present on both sides. Though there was evidence of middle ear disease on the right side, the deafness appeared to be essentially due to some nervous lesion, and was very marked. Taste was doubtfully affected. There were no other symptoms of nervous disorder. I have recently seen this patient, and during the last two years he has been quite well except for the condition of his face and his deafness. The facial paralysis

<sup>1</sup> *Guy's Hospital Reports*, 1895. Vol. LI. pp. 234, 235.

is now less marked than formerly, though still quite a distinct feature. The hearing is not any better, and indeed is so bad that he cannot hear the watch on pressure with either ear, and cannot make out conversation, even in loud tones. There is still tinnitus and some vertigo. There have been no fresh complications, nervous or otherwise, and the patient has been able for work.



# ABDOMINAL SECTIONS IN THE WESTERN INFIRMARY FROM 1894 TILL 1897,

WITH REMARKS BY

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It is only within recent years, and even within the memory of many men in active practice that laparotomy has been developed for the relief of women suffering from disease of the uterus and its appendages. We are proud to know that the case of ovariectomy performed and recorded by Dr. Robert Houston of Glasgow was the first on record, and regret that so many years elapsed before anything further was done.

In 1731 Willins, of Basle, mentioned the operation, and in 1762 Hunter advised the making of a small incision, tapping, securing the pedicle, and removal of the cyst as a proper method of treatment. Chambon, in 1798, advised the removal of diseased ovaries, and Bell included the practicability of ovariectomy in his lectures. Some writers ignore the claims of Houston, and give the credit to Dr. M'Dowall, of Kentucky, who in 1809 successfully removed a large ovarian cyst. It is interesting to know that M'Dowall was a pupil of Bell's.

At long intervals cases were recorded with varying results by Lizars, Clay, and others, but the operation received its greatest impulse from the publication of Sir Spencer Wells' papers in 1864.

As a student, I can remember how Lister and other surgeons dreaded the operation, but since then, step by step, experience has overcome difficulties, until now each of the various stages

in the procedure is founded upon a sound basis. The use of the clamp and the cautery has been totally discarded for ligature of the pedicle, whilst the intra-peritoneal treatment of the stump has entirely replaced the extra-peritoneal method. In connection with sutures and pedicles, it may be mentioned that a very curious case, not cited here, was seen. The patient, who had undergone Caesarean section three years previously, complained of bladder irritation. On examination three calculi were found suspended from the anterior wall of the bladder. Upon removal of these it was found that each consisted of phosphatic deposit upon silk sutures which had made their way into the bladder, but still retained hold of its wall. A year later a fourth calculus was removed, with its silk pedicle, from the same patient. She now enjoys good health.

At the present time, notwithstanding the wonderful results secured by asepsis and antisepsis, opinion still varies as to the best method of closing the abdominal wound, and some operators tend to advocate operation *per vaginam*, instead of abdominal incision. On this point I may be excused if I again refer to Dr. Houston, as he in his ovariectomy used three sutures at equal distances in closing the abdominal wound, whilst much later we read of the use of compresses and a bandage to secure the wound. It was only in 1851 that complete closure of the wound was advocated by Baker Brown, but many still dreaded to puncture the peritoneum, and so carefully avoided its inclusion in the suture. Sir Spencer Wells, in his fourth ovariectomy, made a curious but important discovery. The patient died, but the post-mortem examination revealed the fact that the needles which had been used to close the wound instead of sutures, and did not include the peritoneum, had left their impress upon the intestines, which were adherent. Through experiments upon dogs he found that if peritoneum was brought to peritoneum, complete union of the peritoneal layer was secured, but that if not included the peritoneum retracted, and left the inner surface of the abdominal wound exposed, with the result that adhesions with the intestines took place.

Another great advance was the use of silver wire, which is now replaced by silk-worm gut. This, if perfectly aseptic,

prevents effectively the formation of pus, which previously was thought to be due to the puncture with the needle.

Hernia has been cited as the result of inefficient closure of the wound, and so some operators advocate as an ideal method closure of the wound layer by layer. This is at present a favourite topic in surgical societies. Personally I have met with but few cases of hernia after laparotomy, but they are more frequent after Caesarean section, and result not from the method of closing the wound, but from the spinal curvature, which throws the entire weight of the intestines upon the abdominal wall.

The idea of total extirpation of the uterus is about the latest development of abdominal section. It was previously condemned on account of the difficulties and dangers attending it, such as bleeding, wounding the ureters and sepsis from the vagina. Such objections persistently repeated were looked upon as insuperable, and, in fact, like the fear of wounding the peritoneum, for a time acted as a barrier to all progress.

The treatment of fibroids therefore was limited to medical means, such as iodides and mineral waters.

The disappearance of inflammatory growths which had been looked upon as fibroids also delayed any advance, and so the haemorrhage resulting from such growths continued to be treated by ergot and later by electricity.

Apostoli's method excited much interest, more especially as it was taken up by Sir Spencer Wells, and still more enthusiastically by Keith. Too much, however, was claimed for electrolysis, and very soon it was found that, although beneficial as a haemostatic and tonic, it failed to produce permanent diminution much less to dissolve the tumour.

The wonderful success following ovariectomy led Tait to remove the uterine appendages for the cure of haemorrhage from fibroids with good results, although some allege that such procedure is followed by grave mental disturbance. No doubt this idea arose from the fact that many ovaries were removed for so-called ovarian neuralgia in women, who from their mental condition were unfit subjects for operation.

Keith's greatest success lay in the extension of abdominal surgery to the removal of uterine myoma, an operation which

meant only the removal of the tumour, but which may now include the removal of the entire uterus, either for myoma, sarcoma, or cancer. The following cases are illustrative of the necessity and success of such a procedure.

*Case 25.* Mrs. C., aged 36, was admitted to the Western Infirmary, under my care on July 16th, 1895, complaining of great distension of the abdomen. The patient considered herself about five months pregnant, but as the abdomen was so much distended she consulted me regarding her condition. She stated that she had always enjoyed the best of health until the spring of the present year, that menstruation commenced at the age of 15 and continued perfectly normal and regular until February, 1895, that she had been married for about two years, and had had no children and no miscarriages.

About eight years ago the patient noticed for the first time, and quite by accident, a swelling in the left iliac region. It was about the size of a hen's egg when she first felt it. For a month or two it increased in size slightly, then ceased growing, and remained stationary until she became pregnant at the end of February. On February 19th she menstruated for the last time. Three or four weeks afterwards she began to be troubled with morning sickness, and about the middle of June she felt foetal movements for the first time. She was quite satisfied that she was pregnant: but what troubled her was the fact that her abdomen became so rapidly distended. It was, however, during the six or seven weeks previous to her admission into hospital that the distension seemed to increase most rapidly.

Her general condition on admission was not very satisfactory. There was great oedema of the legs and thighs, but apparently no ascites. There was some dyspnoea. The mucous membranes were of a good colour. She had no difficulty in passing urine, but her bowels had been very constipated. There was nothing abnormal in the lungs and heart; milk could be expressed from both breasts. The abdomen was much distended, presenting the appearance of a pregnancy at full time. It measured 37 inches at the level of the umbilicus. On palpitating the abdominal tumours, a large smooth, round, hard swelling was found to occupy the left side.



It crossed the middle line, and was continuous with a swelling on the right side, from which it was separated however by a sulcus. This swelling on the right side was elastic in consistence, but two or three hard rounded nodules could be distinctly made out upon its anterior surface. The uterine *souffle* could be heard over it, but no foetal heart sounds could be recognized.

On vaginal examination, the whole cavity of the pelvis was filled up with a hard mass firmly impacted into it, and continuous with the tumour above. So completely did this tumour block up the pelvic cavity that the forefinger could with difficulty be passed up the vagina. The uterus appeared to be very much drawn up, as the examining finger could not reach the os externum.

On July 19th the patient was examined under chloroform, but nothing further was made out.

On July 22nd abdominal section was performed. On opening into the abdomen a large irregular tumour was met with, the left portion consisting of an interstitial myoma, the right of the distended uterus. In addition, implanted on the upper and posterior uterine walls, were several subserous myomata, varying in size from a walnut to an orange. Having made an incision through the anterior wall, a foetus of 5 months was removed. It was perfectly formed, and had evidently only quite recently died. The placenta was well developed, and was easily detached. An elastic ligature was passed round the uterus and tumours as close as possible to the cervix and secured, after which the uterus with the tumours were cut away. The uterine and ovarian arteries could now be more easily reached, and were ligatured. The ovaries and tubes were also removed. The tumour blocking up the pelvis was with some difficulty drawn up on account of impaction and adhesions. Having enucleated this mass of tumour nothing remained but the cervix, which was also separated from its connections. The peritoneum was stitched round and round with catgut sutures to the mucous membrane of the vagina. These sutures were then drawn down into the vaginal canal by means of a pair of long forceps passed up into the abdomen through the vagina. The abdominal wound was then closed

with silk-worm sutures; no drainage tube was used. The parts removed weighed 27 lbs.

The patient made a good recovery. She had a little sickness on the third and fourth days, when the temperature thrice registered  $100.2^{\circ}$  F. After that it never rose above  $100^{\circ}$ , and fell to normal after the ligatures were discharged from the vagina on the tenth to the twelfth days. She left the hospital in the seventh week after the operation perfectly well.

*Case 27.* Mrs. J., *act.* 32, was admitted on May 1st, 1896, complaining of swelling in lower part of abdomen, and discharge from the vagina. The swelling was first seen several years ago, and the discharge has been present for eighteen months.

Menstruation began at twelve years and was regular and natural until September last. Since then the discharge has habitually persisted for a fortnight at each period. Patient states that within the past eighteen months the growth has been very rapid. No pain was experienced till six weeks ago, but since then the pain has been at times very severe.

Examination of the abdomen reveals a very large tumour filling the cavity. It is hard and resistant, but not tender to the touch.

Operation was deemed advisable. The tumour and entire uterus were removed. The patient made a good recovery, and was dismissed in six weeks.

*Case 30.* Mrs. M'K., *act.* 40, was admitted on June 16th, complaining of swelling of the belly. The tumour was first noticed eight years ago, and has grown gradually since, being associated with pain from time to time. The uterus is dragged up, so that the top of the vagina can scarcely be reached.

The tumour, with the entire uterus, was removed. Numerous cystic developments were found in the growth, which was a myoma, weighing over ten pounds. Patient dismissed well.

*Case 7* was sent in as one of ovarian cyst, but it was thought that the swelling was in connection with the liver, and so it was sent to the medical wards. It was however returned, and so an exploratory incision was determined upon. The cyst was found to be due to enlargement of the gall bladder, which was distended till it formed a large swelling in the abdomen. This

was opened, and three gall stones removed, one of them being as large as a nutmeg. The patient made a complete recovery.

Cases 31, 46, 47, and 49 are examples of pelvic haematocele, another condition which has come to be recognized as requiring surgical treatment. These in most cases become encysted through the resulting peritonitis. For a long time the pathology of these cases was a matter of speculation, and a very common idea was that of Bernutz, viz. menstrual regurgitation. I remember distinctly how I was warned against tying or dividing the Fallopian tubes in Caesarean section to prevent subsequent conception. Such an act, I was told, would most surely be followed by an escape of the blood from the tube and ruptured Graafian follicle. In every case, now numbering about fifty, the tubes were tied, and until now, a period extending over ten years, not a single case has resulted from this cause.

At present, from observation and early operation, we have established the fact that in those cases of intra-uterine haematocele not arising from some traumatic cause, the origin is most likely due to the rupture of an ectopic pregnancy. As to whether the effused blood will become encapsuled much will depend not only upon the quantity of blood effused, but upon the rapidity of its effusion, whether through a lacerated tube or through its pervious abdominal ostium. Many cases of tubal clot or mole have been recorded, and probably such are the cases which do well without operative interference.

The embryo appears in many cases to perish in the tube at an early stage, and the case resolves itself into haemato-salpinx, with or without effusion of blood into the peritoneal cavity, through the abdominal ostium of the tube.

Case 24 was an irreducible retroversion of the gravid uterus. As this is the only instance I have ever met in which reduction was impossible, I consider it deserves special notice.

Mrs. M., aged 35, housewife, was admitted to Ward VII., Western Infirmary, under my care on December 12th, 1895, complaining of a painful swelling in the abdomen of about five weeks' duration. She had always enjoyed excellent health. She was married at the age of twenty-one (fourteen years ago), and has had four children born alive and at full time; the



labours were normal, and she made a good recovery after them all, and has never had a miscarriage. Menstruation has always been regular except during pregnancy and lactation; her last period, on August 4th, lasted three days. She considered herself pregnant: was perfectly well, not even suffering from the usual discomforts of the early months, until about five weeks ago, when, as she describes it, her "urine stopped." Simultaneously with this she observed that her whole abdomen was enlarged so that she could not put on her usual clothing. A doctor was called in, and attended her until her admission to hospital. Her medical attendant informed me that the swelling persisted, and she was able to pass her urine only in "drops." This retention of urine was accompanied by pain and a feeling of distension in the lower part of the abdomen, with vomiting and constipation.

On Tuesday, December 3rd (seventeenth week of pregnancy), the catheter was passed for the first time, and 80 ounces of urine were drawn off. After this the swelling of the abdomen was found to be much reduced in size. It increased on the following day, but was again lessened by the withdrawal of a large quantity of urine. Mixed with the urine on this occasion, however, and for the first time, was a large quantity of blood. Since then blood has been present in the urine almost constantly, and during the last two days in a very much larger quantity.

On Sunday last, December 8th (early eighteenth week), the patient was rather better, and was allowed to rise for a little. This improvement, however, continued only for a couple of days, for on the 11th, the day before admission to the hospital, she was seized suddenly with what she described at the time as "labour pains," accompanied by a haemorrhagic discharge from the vagina. Dr. Fenwick, Dr. Miller, and finally myself were summoned in consultation, and we agreed that immediate removal to hospital was most desirable.

The following is the note of her condition on admission to the Western Infirmary: Patient is very anaemic. On inspection the abdomen is seen to be distended by a swelling which occupies the hypogastric, iliac, umbilical, and lumbar regions, and reaches almost to the xiphoid cartilage. It is



of somewhat doughy consistency in parts and painful in the flanks and both iliac regions. Percussion gives a dull note over the front of the abdomen and towards the flanks, but at the extreme sides the note is clear. The tumour is movable from side to side to a slight extent. Fluctuation is not present in any part of the tumour. On examination *per vaginam* a bulky dense mass is found filling the pelvic cavity, and firmly fixed in the pouch of Douglas. The os uteri cannot be reached by the examining fingers except under chloroform, when it is found situated above the symphysis pubis. Its posterior lip appears continuous with the swelling described. Before the operation the bladder was several times irrigated, when numerous blood-clots, shreds of mucus and epithelium were washed out. On withdrawal of the catheter on one occasion a blood cast of the ureter, some fifteen inches long, and about the thickness of a quill, was expelled. On December 13th, that is, at the end of the eighteenth week of pregnancy, I performed abdominal section, as the patient's condition was becoming critical. The incision had to be extended above the umbilicus before the peritoneal cavity could be reached, owing to the distended condition of the bladder, and even then the uterus could not be reached.

In order to empty the bladder an opening was made upon its anterior wall, extraperitoneally, and a large quantity of blood-stained urine and clot was extracted. This organ contracted almost like a uterus, showing the walls greatly hypertrophied. The uterus and left Fallopian tube were now reached, but the right tube was imprisoned in the pelvic cavity, with the impacted uterus. My assistant, Dr. Munro Kerr, introduced his hand into the vagina, and made steady pressure upwards, whilst I disengaged the uterus at the brim by careful traction forwards from the sacrum with my fingers. This was only effected with great difficulty. The bladder incision was then sutured with fine silk, and the abdominal incision in the usual manner with silkworm sutures. A double-winged catheter was retained in the bladder.

The patient, I am glad to say, made an uninterrupted recovery. The temperature on only two occasions registered more than  $99.4^{\circ}$ —that is,  $100^{\circ}$  on December 30th, a week

after the operation, and  $100.4^{\circ}$  on the 31st. The pulse likewise, except during the first two days, continued normal. She complained of some pain in both iliac fossae for the first week; it was always relieved by  $\frac{1}{4}$  gr. morphine suppository. It was not continuous, and never suggested impending abortion. The condition of the urine improved rapidly after the operation, so much so that in two days blood could only be detected by test, and a week after not a trace of it was to be found. The uterus steadily increased in bulk until her dismissal. On January 2nd movements of the foetus were distinctly felt by the patient, and a week later the foetal heart-sounds were clearly made out. The patient left the infirmary on January 18th, six weeks after the operation, in perfect health.

The history of this case clearly shows the necessity for careful examination, as the physician too frequently attributes all the suffering to the fact of pregnancy existing. Frequently the retention of urine calls for relief, and then the displacement may be detected. Denman blamed a distended bladder for retroversion; perhaps he would have been nearer the truth had he put the retention of urine down as resulting from displacement. Independently of pregnancy, retroversion and retroflexion are very common, especially in women who have borne children. Should pregnancy supervene, the uterus may continue to develop until it becomes locked in the true pelvis. Again, the retroversion may result from some adhesions behind preventing the ascent of the fundus, or even suddenly from some exertion or fall whilst the bladder is distended.

Upon May 18th I received the following message from her doctor: "On Sunday, 17th, Mrs. M., of the retroverted uterus, of a large healthy male child. Abdominal wall lovely. Forceps at the brim. A stiff pull."

TABLE OF CASES.

	Name.	Age.	Married or Single.	Disease.	Operation.	Result.
1	E. E.	30	S.	Myoma of uterus, -	Myomectomy, -	Died.
2	M'L.	34	M.	Fibro-cystic tumour, -	Abdominal Section, -	Cured.
3	L.	50	M.	Fibro-cystic tumour, -	Abdominal Section, -	Cured.
4	R.	36	M.	Cyst of ovary, -	Ovariectomy, -	Cured.
5	M'C.	30	S.	Myoma of uterus, -	Oophorectomy, -	Cured.
6	R.	38	M.	Cyst of ovary, -	Ovariectomy, -	Cured.
7	G.	53	M.	Distended gall bladder, -	Cholecystomy, -	Cured.
8	H.	33	S.	Myoma, -	Oophorectomy, -	Died.
9	C.	28	M.	Encysted ascites, -	Abdominal Section, -	Cured.
10	M'F.	21	M.	Ovarian cyst, -	Ovariectomy, -	Cured.
11	M'L.	33	M.	Ovarian cyst, -	Ovariectomy, -	Cured.
12	W.	31	M.	Ovarian cyst, -	Ovariectomy, -	Cured.
13	M.	23	M.	Encysted ascites, -	Abdominal Section, -	Cured.
14	D.	23	M.	Ovarian cysts, -	Ovariectomy, -	Cured.
15	C.	36	M.	Myoma with pregnancy, -	Panhysterectomy, -	Cured.
16	S.	35	M.	Myoma of uterus, -	Myomectomy, -	Cured.
17	A.	24	S.	Ovarian cyst, -	Ovariectomy, -	Cured.
18	M'L.	36	M.	Ovarian cysts, -	Ovariectomy, -	Cured.
19	B.	35	S.	Ovarian cysts, -	Ovariectomy, -	Cured.
20	M'L.	38	M.	Ovarian cyst, -	Ovariectomy, -	Cured.
21	M.	35	M.	Incarcerated retroversion with pregnancy, -	Laparotomy, -	Cured.
22	E.	30	M.	Ovarian cysts, -	Section. Uterus replaced, -	Cured.
23	C.	35	S.	Ventral hernia, -	Ovariectomy, -	Cured.
					Abdominal Section, -	Cured.

TABLE OF CASES—Continued.

	Name.	Age.	Married or Single.	Disease.		Operation.	Result.
24	Y.	29	S.	Ovarian cyst, -	-	Ovariectomy, -	Cured.
25	D.	23	M.	Ovarian cyst, -	-	Ovariectomy, -	Cured.
26	J.	32	S.	Myoma of uterus, -	-	Panhysterectomy, -	Cured.
27	F.	42	M.	Ovarian cyst, -	-	Ovariectomy, -	Cured.
28	C.	29	M.	Haemato salpinx, -	-	Abdominal Section, -	Cured.
29	S.	70	M.	Ovarian cyst, -	-	Ovariectomy, -	Cured.
30	M.K.	40	M.	Myoma of uterus, -	-	Panhysterectomy, -	Cured.
31	S.	46	S.	Ovarian cyst, -	-	Ovariectomy, -	Cured.
32	L.	21	S.	Ovarian cyst, -	-	Ovariectomy, -	Cured.
33	F.	36	M.	Double dermoids, -	-	Abdominal Section, -	Cured.
34	N.	20	S.	Ovarian cyst, -	-	Ovariectomy, -	Cured.
35	O.H.	23	S.	Ventral hernia, -	-	Abdominal Section, -	Cured.
36	B.	40	M.	Ovarian cysts, -	-	Ovariectomy, -	Cured.
37	K.	24	S.	Ovarian cysts, -	-	Ovariectomy, -	Cured.
38	L.	27	S.	Ovarian cysts, -	-	Ovariectomy, -	Cured.
39	M.L.	27	M.	Encysted peritonitis, -	-	Abdominal Section, -	Cured.
40	F.	29	S.	Ovarian cyst, -	-	Ovariectomy, -	Cured.
41	C.	38	M.	Ovarian cyst, -	-	Ovariectomy, -	Cured.
42	B.	32	M.	Ectopic pregnancy, -	-	Abdominal Section, -	Cured.
43	W.	?	M.	Ovarian cyst, -	-	Ovariectomy, -	Cured.
44	M.G.	32	S.	Haematoma, -	-	Abdominal Section, -	Cured.
45	F.	17	S.	Ovarian cyst, -	-	Ovariectomy, -	Cured.
46	B.	34	M.	Ovarian cyst, -	-	Ovariectomy, -	Cured.
47	T.	27	M.	Ovarian cyst, -	-	Ovariectomy, -	Cured.



MALFORMATIONS OF THE KIDNEY,  
AND DISPLACEMENTS WITHOUT MOBILITY,  
WITH ILLUSTRATIVE CASES AND SPECIMENS.

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ANOMALIES of the kidney have until recently been looked upon simply as pathological or anatomical curiosities; but now that many of the diseases of the kidney come to be placed under the surgeon for treatment by operation, all departures from the normal, whether in respect of number, form, size, or situation, must be considered of moment to those who have frequently to operate upon the renal organs. The amount of literature on the subject published within the last ten years is a testimony to this.

Since early times anomalies in size, situation, and form of the kidney have been recorded, but very often only as curiosities, and little attention was given by the authors to points of detail. Recently, however, the records of cases have been carefully given, and much interest has been shown in the subject from the surgical, as well as from the pathological, stand-point.

Vesalius, Spigelius, Duretus, Valsalva, and Sylvaticus were about the earliest authors to describe the anomalies we are about to consider; since their time many hundreds of cases have been recorded, so that now we have a considerable basis to work upon.

We shall not endeavour to reconcile the various classifications of malpositions and malformations of the kidney which have been advanced from time to time.

If we simply study the cases recorded it will be found that they group themselves together, and may be naturally classified under the following heads:—

- A. DISPLACEMENTS WITHOUT MOBILITY: I. Congenital displacement without deformity; II. Congenital displacement with deformity; III. Acquired displacements.
- B. MALFORMATIONS OF THE KIDNEY: I. Variations in number: (1) Supernumerary Kidney; (2) Single Kidney, (*a*) Congenital absence of one Kidney, (*b*) Atrophy of one Kidney; (3) Absence of both Kidneys. II. Variations in form and size: (1) General variation in form, lobulation, etc. (2) Hypertrophy of one Kidney; (3) Fusion of two Kidneys; (*a*) Horse-shoe Kidney, (*b*) Sigmoid Kidney, (*c*) Disc-shaped Kidney.
- C. VARIATIONS IN PELVIS, URETERS, AND BLOODVESSELS.

- A. DISPLACEMENTS WITHOUT MOBILITY: I. Congenital displacement without deformity of the organ is by no means uncommon.

Perhaps no organs in the body vary more in their position than do the kidneys. Their relative distance from the spine, and their position in relation to other organs, is observed to vary considerably. For instance, without any evident cause one kidney may be found close up to the spleen, almost touching the diaphragm and the vertebral column, while the other organ is situated considerably below the crest of the ilium, and removed some distance from the spine. From observations which I made regarding this point, it seems clear that malposition of the kidney within certain limits is of frequent occurrence, and may exist without causing any disturbance. In 1000 post-mortem examinations, 24 instances occurred where the position of one or both kidneys might be described as abnormal. In 9 of these cases there was also malposition of the suprarenal capsule. Malposition of the kidney does not therefore necessarily involve an alteration in the position of the suprarenal capsule, although the intimate anatomical relationship which exists between them might lead one to

expect that any condition causing the kidney to occupy an anomalous position would also cause a disturbance of the corresponding suprarenal body.

### CASE 1.

*Fixed displacement of the right kidney above Poupart's ligament simulating a perityphlitic abscess. Operation.<sup>1</sup>*

The patient was admitted to the Glasgow Royal Infirmary on the 2nd of November, 1894, complaining of pain in the

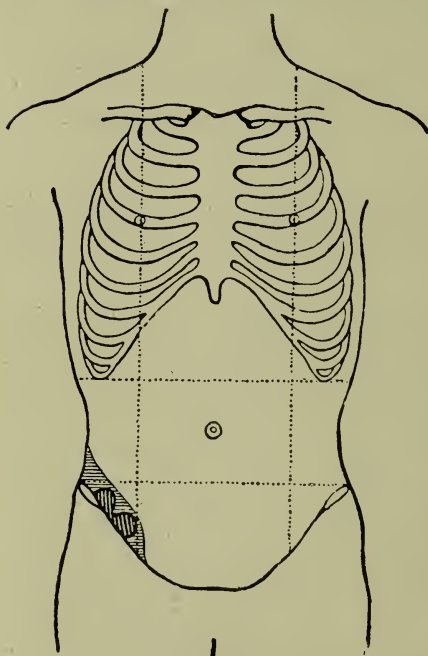


FIG. 1.

right iliac region. In September, 1890, he began to complain of pain in the lower dorsal region, but although the pain continued with more or less persistence, he continued at his work till the winter of 1893. It then became so severe that he went to bed and remained there for over a month. He first felt pain in the abdomen about this time, and for six months after this he could walk about only with the aid of two sticks; the swelling in the abdomen he noticed about seven months before his admission. There was a slight fulness of the

abdomen in the right iliac and lower lumbar regions, and a rounded swelling was felt passing upwards and backwards. It appeared to be fluctuant. The dulness on percussion

<sup>1</sup>This case is published in detail in the *Scottish Medical and Surgical Journal*, Vol. I. No. 1, p. 53.

did not exactly coincide with the opinion formed of the size of the swelling as made out by palpation; it was obtained over an area of about two inches in breadth running parallel with Poupart's ligament. The swelling was cut down upon, and as soon as the muscles were cut through the sense of fluctuation was lost. The incision was then enlarged, when the swelling was found to have a rounded outline with a distinct hilum towards the inner and upper aspect, and being semi-elastic but firm, immediately suggested a displaced kidney (Fig. 1).

A very thick adipose capsule was dissected through and the kidney exposed. It was quite immobile. There was no enlargement or hydronephrosis. The condition of the ureter could not be made out. The wound healed in a few days, after which the sense of fluctuation was again as deceptive as on admission.

### CASE 2.

*Left kidney displaced downwards and forwards in a patient upon whom lumbar colotomy was performed.*

The patient was admitted to Sandyford Nursing Home early in 1897, suffering from malignant disease of the rectum, and it was resolved to perform a lumbar colotomy.

On making an incision from the lower border and tip of the last rib on the left side to a point half an inch behind the centre of the crest of the ilium, the upper border of the left kidney presented itself at the lowermost limit of the incision. When first felt by the finger in the wound, some doubt was entertained as to the nature of the hard mass; but by drawing aside the surrounding adipose tissue, the renal cortex was easily recognized. The kidney, as far as could be made out, was normal in size and form, except that the surface was slightly lobulated (Fig. 2).



## CASE 3.

*Right kidney displaced downwards and rotated on its antero-posterior axis, shortened ureter entering upper aspect of bladder.*

The patient was admitted to the Glasgow Royal Infirmary in September, 1887, and died from severe abdominal injury with rupture of the liver and spleen.

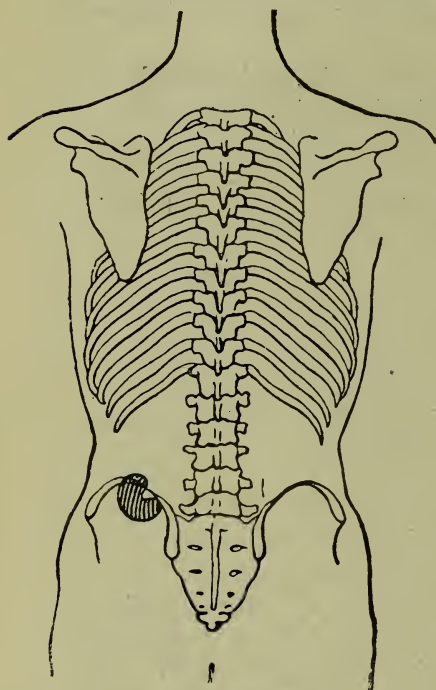


FIG. 2.

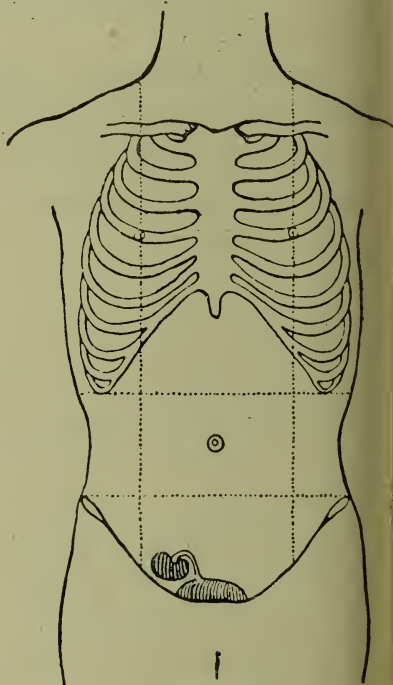


FIG. 3.

At the post-mortem examination the right kidney was found to be displaced and firmly fixed, the pelvis of the kidney looked upwards, inwards, and forwards, while the convex aspect of the organ rested upon the brim of the pelvis. The kidney was normal in shape and size, and the vessels were natural in their distribution, with the exception that both the renal artery and vein were elongated, while the right ureter was shortened and entered the bladder close to the upper

aspect of that viscus. The left kidney, with its vessels and ureter, was strictly normal (Fig. 3).

In the three cases above described, where the kidneys occupied abnormal positions, the fixed misplacements were not associated with any deformity of the organs.

## II. CONGENITAL DISPLACEMENT WITH DEFORMITY.

The alteration in the form of the kidney seems in some instances to depend upon the situation occupied by it, as for example in a case described by M. Aubé where the left kidney was found between the common iliac arteries, close to their origin from the aorta. Pacoud narrates another, in which a kidney was found situated in the pelvis between the rectum and bladder, and somewhat similar instances have been described by Drouin, Bellini, Andral, Bonet, and others.

In my own cases, and in those referred to by these observers, alteration in form of the displaced organ undoubtedly to some extent depended on the situation occupied by it. For example in M. Aubé's case the kidney was flattened, and its anterior surface divided into three parts by two depressions formed by the passage of the two arteries. As a general rule, malpositions of the kidney are associated, particularly when the displacement is congenital, with some deviation from the normal in regard to the position of the large intestine and peritoneum, and, not uncommonly, the distribution and number of the bloodvessels, and the course and length of the ureters are found to be abnormal. Roberts states that in twenty-one cases of congenital malposition of the kidney, which he was able to collect and compare, the abnormality was in every instance confined to one kidney; and the left kidney was much more commonly affected than the right (left 15, right 6). Most frequently the kidney was found lying obliquely on the sacro-iliac synchondrosis. In some cases the organ was fixed beside the uterus, or transversely between the rectum and the bladder, or across the prominence of the sacrum.

As a rule the displaced organ has its long axis vertical or slightly oblique, but it may also occupy, as illustrated by

a case published by Carslaw,<sup>1</sup> a transverse position. In this case the left kidney was found lying on the fourth and fifth lumbar vertebrae, and the long diameter was, transversely from right to left, three inches. The kidney was divided into two lobes, by a fissure running on the anterior surface almost vertically. The ureter was double, one branch coming from each lobe, but these united while still in the hilum of the kidney. Two arteries supplied the kidney, one from the aorta and a second from the right common iliac, and corresponding with each artery there was a vein.

These congenital displacements will be more fully described under malformations of the kidney. At present we may give the following cases in illustration of the subject:

#### CASE 4.

*Right kidney at the brim of the pelvis, anomalous distribution of blood-vessels, and deformity of the kidney.*<sup>2</sup>

The right kidney was found lying on the brim of the pelvis. The anterior aspect of the organ is convex, the posterior surface slightly concave. The front of the organ is marked by a deep groove extending from its upper to its lower extremity. This groove is, roughly speaking, Y-shaped, the right limb of the Y being longer and deeper than the left. At the upper limit of the former an artery enters the kidney directly from the aorta, and before entering the substance of the organ it divides into two branches of equal size. In the centre of the groove, where the two limbs of the Y join, the pelvis of the kidney is seen, and the ureter passes directly down from it. From the kidney, close to the uppermost limit of the pelvis a large vein passes directly to the vena cava. The posterior aspect of the kidney is flat or slightly concave and is penetrated by two vessels, one a vein which passes from the kidney up its lowermost margin to the common iliac vein, and the other an artery, which arises from the

<sup>1</sup> *Glasgow Medical Journal*, Vol. xxxi., p. 381.

<sup>2</sup> Royal Infirmary Museum, Series vii., No. 2.

common iliac artery, and penetrates the kidney at the union of the lower and middle thirds.

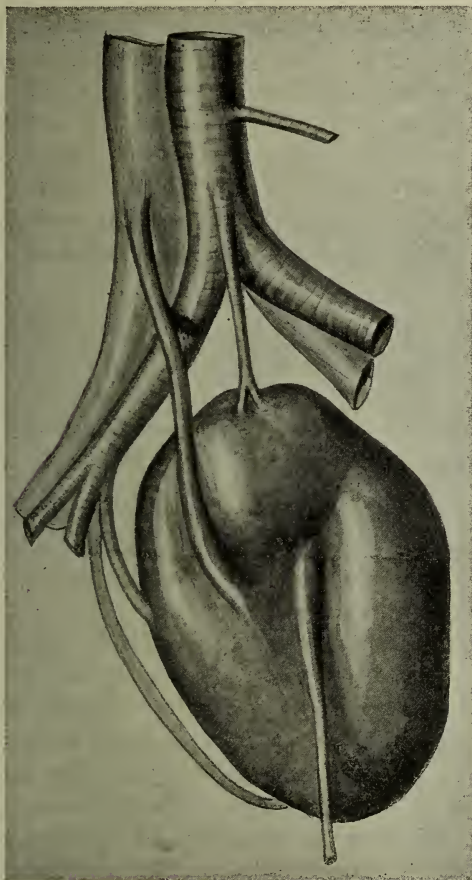


FIG. 4.

### CASE 5.

*Malposition of both kidneys, one to the right of the promontory of the sacrum, the other in the iliac fossa. Right kidney small and with no hilum.<sup>1</sup>*

In this case the kidney was found to be situated about half an inch to the right of the promontory of the sacrum,

<sup>1</sup> Newman, *Surgical Diseases of the Kidney*, page 7.



and the left kidney was discovered in the left iliac fossa two inches to the left of the sacro-iliac synchondrosis. The right kidney was small in size and so altered in shape that there was no hilum, and the ureter passed from the lower aspect of the organ. The parenchyma of the kidney was normal in appearance, and the arteries, two in number, came off from the aorta about one inch above its bifurcation. The left kidney was normal in every respect except its position. There was no evident cause for the abnormality; the other abdominal organs were practically normal, and there was no indication of inflammatory or other mischief within the abdomen.

#### CASE 6.

*Right kidney flat, oval in form, and situated at the brim of the pelvis, supplied with two arteries; one ureter from its anterior aspect.*<sup>1</sup>

In this case the right kidney was situated at the brim of the pelvis, half in the cavity, and half out. The preparation was removed from the body of a man aged 61, who died of erysipelas in the Royal Infirmary.

The right kidney forms a flat oval body about the normal size. It is marked by three grooves on its anterior aspect which correspond to the line of the entrance of the blood-vessels and exit of the ureter. The organ is supplied by two arteries which pass off from the aorta in the middle line in front, just above the bifurcation. These vessels pass slightly to the right, and enter the kidney on its anterior aspect, about one-third from the upper border. The arteries lie each in a separate groove as they pass along the upper third of the kidney, and the grooves demarcate a triangular piece of the organ. The right renal vein passes to the vena cava about one inch above the level of the bifurcation of the aorta, and the vein passes from the kidney along the same groove as the arteries enter it; the ureter also arises from the anterior aspect and passes down in front and has a somewhat tortuous course to the bladder, as if it were too long for the distance to

<sup>1</sup> Royal Infirmary Museum, Series VII., No. 1.

be traversed. The right suprarenal capsule is in its normal position close to the liver. The right kidney was firmly fixed in its abnormal position. No other irregularities were discovered in the vessels. The inferior mesenteric artery came off just above the bifurcation of the aorta (Fig. 5).

The left kidney was normal in size and in its relations, but it showed a distinct tendency to lobulation. The anterior aspect of the organ being marked by three distinct transverse grooves.

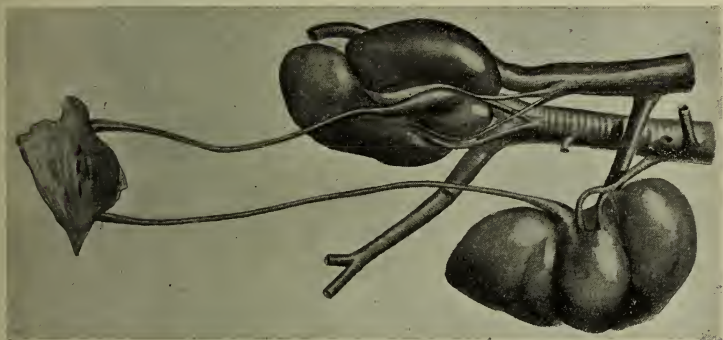


FIG. 5.

Two specimens, very similar to the above will be found in the Western Infirmary Museum, and they are described in a recent paper by Dr. L. R. Sutherland and Dr. G. H. Edington.<sup>1</sup>

In the first case the right kidney, which was found lying at the brim of the pelvis, is greatly altered in form and in relations. The posterior surface is flattened, showing a groove accommodating the right common iliac artery. The anterior surface shows four prominent lobules surrounding the hilum, from which the pelvis springs; the ureter is normal. Two veins emerge, one on either side of the hilum, the left passes upwards in front of the aorta to empty into the left renal vein, while the right empties directly into the inferior vena cava. The right kidney is supplied by two arteries which arise separately from the anterior aspect of the aorta, and pass in grooves to the upper part of the hilum (Fig. 6).

<sup>1</sup> *Glasgow Medical Journal*, February, 1898.

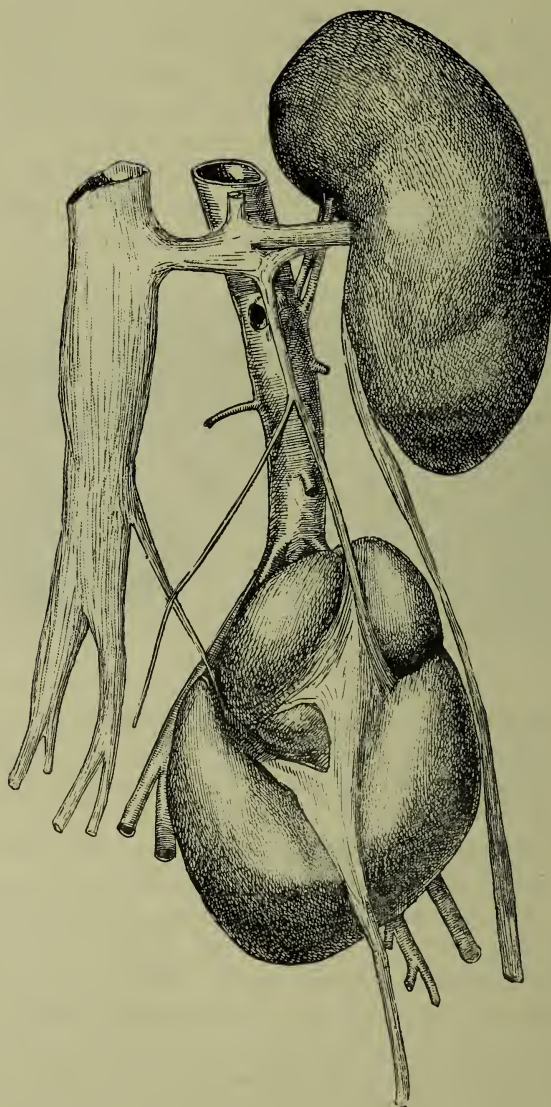


FIG. 6.

In the second case the right kidney was found at the level of the bifurcation of the aorta, and to the right of that vessel. In this case also the hilum is situated anteriorly; and the

bloodvessels, three in number, arise directly from the aorta. The veins unite to form a common trunk, which empties into the vena cava above the junction of the common iliac veins.

The pelvis is bifid, and the two limbs pass from the kidney at different levels, the left one being the higher. The ureter comes from the lowermost limit of the united pelvis. It passes downwards and inwards, lying in a shallow groove on the anterior surface of the lower lobe (Fig. 7).

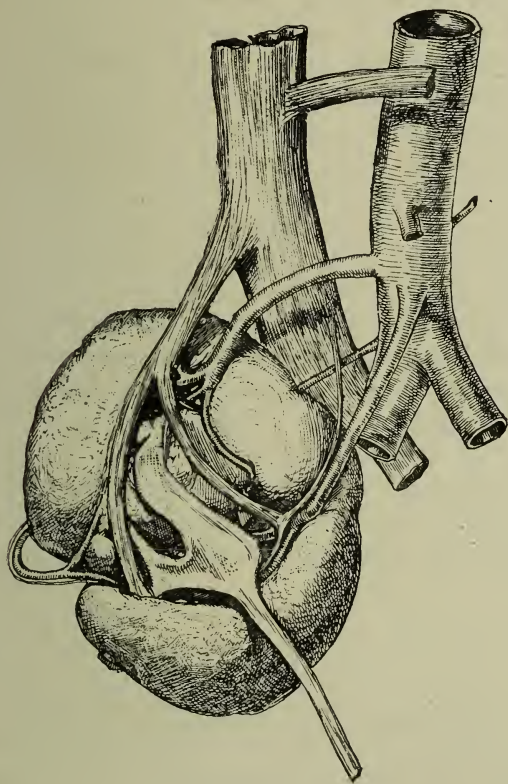


FIG. 7.

These remarkable cases of malposition of the kidney seldom give rise to serious symptoms, and generally escape observation during life.

Cases, however, have been recorded where the misplaced



kidney has been mistaken for an abdominal tumour, or, in the female, has from its position in the pelvis become a serious obstacle to parturition.

### III. ACQUIRED DISPLACEMENT OF THE KIDNEY.

Besides being liable to congenital malposition the kidney may be displaced upwards, downwards, or laterally from the enlargement of other organs, such as the liver, spleen, suprarenal capsule, or pancreas, or from the pressure of tumours near them. When the right kidney is depressed by an enlarged liver—not an uncommon accident—it is most usually rotated on its short axis, the hilum is turned downwards, and the upper portion of the kidney is more depressed. Rayer mentions an instance where the right kidney was forced down by an enlarged suprarenal body, and cites a case of Hohl's where the kidney, situated deeply to the inner side of the psoas muscle, offered an obstruction to parturition by retarding the passage of the child's head; Laennec also describes a case in which the right kidney was pressed downwards to the opposite iliac crest by a greatly enlarged liver, and Morris mentions an instance where the left kidney was depressed on to the brim of the pelvis by a large cyst in its lower part, which contained a pint of yellow fluid. The cyst had dragged the kidney down, and itself occupied the greater part of the pelvic cavity.

#### CASE 7.

##### *Acquired displacement of the right kidney by a perinephric abscess.*

In a case of perinephric abscess upon which I operated in 1890, on opening the abscess by a lumbar incision, after the pus was evacuated, great difficulty was experienced in finding the kidney. By enlarging the incision upwards, the kidney was discovered with its convexity looking upwards, and lying close to the diaphragm, while the pelvis was turned downwards. The kidney was quite denuded of adipose tissue so that its

contour could be easily made out, the organ was firmly fixed in its abnormal position, probably by inflammatory adhesions, and, as far as could be discovered by examination with the finger, the upper border of the kidney was resting on the vertebrae, while the renal bloodvessels and ureters must have been elongated.

Many similar cases have been recorded where the kidneys have been displaced in one direction or another and anchored by their vessels and ureter. The displacements naturally cause rotation of the organ on its short axis.

Probably the most important fixed displacements, either congenital or acquired are those where the kidney comes to occupy the cavity of the pelvis, or where the organ is placed in such a position as readily to be mistaken for an abdominal tumour.

When the kidney has been displaced and occupies the cavity of the pelvis, the swelling may possibly be made out by a rectal or vaginal examination, but in all cases the diagnosis is extremely difficult, as in many instances the organ is not only displaced but also malformed, so that the normal reniform outline is lost as a guide in diagnosis. When, however, the normal shape is maintained it is an important aid to the diagnostician, and when superadded to the presence of a reniform swelling in an abnormal situation there is a loss of the usual fulness and resistance in the loin, a suspicion of misplacement of the kidney may be aroused.

Fixed malpositions of the kidney have seldom been diagnosed, as they almost never give rise to symptoms or even to inconvenience during life. Up to the present time most of these anomalies have been discovered after death, but now that operations upon the kidney are of frequent occurrence, the clinical aspect of the subject is likely to be more fully recognized.

#### B. MALFORMATIONS OF THE KIDNEY : I. Variations in number :

- (1) Supernumerary kidney ; (2) Single kidney, (*a*) Congenital absence of one kidney, (*b*) Atrophy of one kidney ; II. Variations in form and size : (1) General

variations in form, lobulated kidney ; (2) Hypertrophy of one kidney ; (3) Fusion of two kidneys, (a) Horse-shoe kidney, (b) Sigmoid kidney, (c) Disc-shaped kidney.

B. MALFORMATIONS OF THE KIDNEY : I. Variations in number :

(1) *Supernumerary kidney* : Supernumerary kidney is extremely rare. It must be considered simply as an anatomical curiosity, and consequently very little requires to be said regarding the condition. Although very few instances have been met with where more than two kidneys exist in the human subject, still cases have been recorded by Rayer, and other writers, where a supernumerary gland has existed. We have only seen one instance of this anomaly ; it was at a post-mortem examination which was made many years ago upon a gentleman who died from malignant disease of the ascending colon. As no record was kept beyond what was sent at the time to the family attendant, I am unable to give details ; but, from a clear recollection of the case, I can say that lying close to the upper margin of the left kidney there was a small pear-shaped body, supplied by a branch of the renal artery, and having a distinct ureter which passed into the left ureter half an inch below the pelvis of the left kidney. Sections of this mass were examined microscopically, and found to be healthy renal tissue. The mass was completely separated from the kidney proper, being united to it only by the little ureter.

This anomaly may be regarded as an extreme variety of segmentation of one of the kidneys. Generally when a supernumerary kidney has been seen, it has been found to lie close to a normal kidney, but in order to be placed in this class of malformations, the part ought to be so separated as to possess distinct vessels and have a ureter of its own, which, however, always unites with the ureter of the normal kidney before it reaches the bladder.

(2) *Single kidney*. The anomalies which have been included under this term have been so various and so entirely different, even in their main characteristics, that it is difficult to avoid confusion, and at the same time follow the classification at present adopted.

The existence of so-called "single kidney" was known to many of the older writers such as Vesalius, Duretus, and Eustachius, but Morgagni, in 1769, was the first writer to classify these abnormalities of the kidney into two groups, namely: those instances in which two organs had become coalesced; and secondly, those where only one kidney had developed; but unfortunately to both of these conditions he applied the term "solitary kidney." Then, following upon Morgagni, Rokitansky limited "solitary kidney" to those cases in which the malformation was due to the fusion of two organs, of which the lowest degree is seen in "horse-shoe kidney," and the highest in those instances in which the two kidneys approach one another more and more, and form one "disc-shaped" organ lying in the median line, and provided with a double ureter. To the other class of kidneys where there is a "right or left kidney which is normal in regard to position and formation, and occasionally rather enlarged, its fellow being deficient," he applied the term "unsymmetrical kidney." We do not understand why two kidneys fused together as in horse-shoe kidney, where the two organs may be united only by a narrow band (see Fig. 12) and having distinct sets of vessels and ureters, should be spoken of as a "solitary" or "single kidney," any more than that the double monsters Eng and Chang should be considered as one individual. So much confusion has arisen regarding the use of the terms "unsymmetrical kidney" and "solitary kidney," that it would be well not to employ them. For example, "sigmoid" kidney, a condition where two kidneys are fused together, as shown in Fig. 16, and occupying one side of the body, has been described under the heading "solitary kidney," even although the mass was provided with a double set of vessels and two ureters.

Under the term "single kidney" we purpose only to include those cases in which one active organ is found, either as a consequence of atrophy, or from congenital absence of its neighbour. The other abnormalities, such as "horse-shoe kidney," "sigmoid kidney," and "disc-shaped kidney," may be considered under the general heading of "fused kidney."



A careful distinction must be drawn between "single kidney" due to congenital defect of development of the opposite organ, and those instances in which a kidney has become wasted and functionally useless as a consequence of disease, while its neighbour has undergone compensatory hypertrophy.

In the former instance no trace of the kidney or of its ureter, or bloodvessels is found, as shown in Fig. 8, while in atrophy of one kidney as a consequence of disease the rudimentary kidney and its vessels are as a rule represented.

The following specimens illustrate (a) *congenital absence of one kidney*:

#### CASE 8.

*Complete absence of the left kidney, ureter, and vessels. Compensatory hypertrophy of right kidney.*

On the 23rd June, 1885, we made a post-mortem examination on a patient, Mrs. H., aged 53, who was admitted to the Royal Infirmary under the care of the late Dr. Scott Orr, and died from tubercular ulceration of the bowels and secondary tubercular peritonitis (Fig. 8).

The right kidney was normal in its position, but the whole organ was greatly enlarged, weighing  $12\frac{1}{2}$  ounces, and measuring 5 inches in length and 4 inches in breadth. All the parts of the kidney were proportionately increased, the right ureter and pelvis were strictly normal, and the kidney was supplied by one artery and one vein, both of which were normal in their course and distribution. The right suprarenal body was normal in size and situation, the left suprarenal body was found under the last left rib and was normal in size and structure. No trace was found of the left kidney or of its vessels and ureter, and no opening into the bladder could be discovered corresponding to the entrance of the ureter.

The microscopic examination of the enlarged kidney was gone into very carefully and the inquiry was a most interesting one, showing very clearly how compensatory hypertrophy takes place.

The minute changes occurring in compensatory hypertrophy we have described elsewhere. They do not demand attention here, further than to say that as far as could be made out the

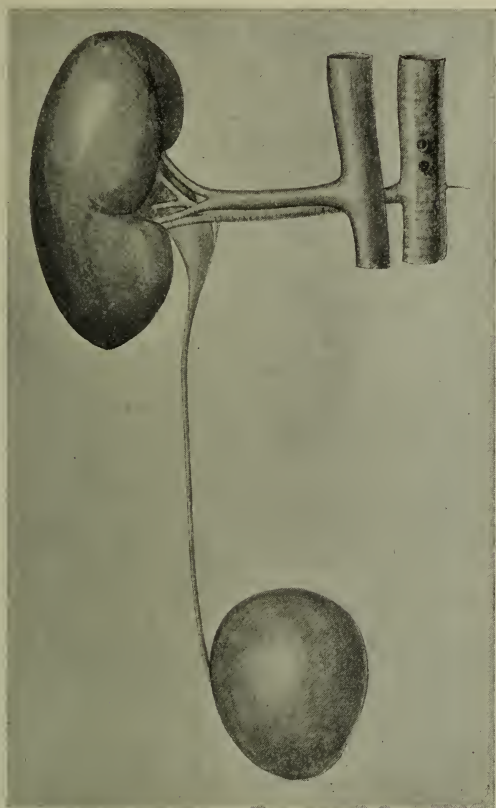


FIG. 8.

increase in the size of the kidney was due to an augmentation in the bulk of the glomeruli, and to an elongation and increased convolution of the uriniferous tubules, rather than to any numerical hyperplasia.

The changes taking place in compensatory hypertrophy have been carefully studied by Eckardt, Ebstein, Guttmann, Polk, and others.

## CASE 9.

*Congenital absence of the left kidney, vessels and ureter.*

The specimen about to be described was placed in the Museum of the Glasgow Royal Infirmary by Dr. J. Lindsay Steven, and in the Catalogue is described by him as follows:<sup>1</sup>

"The preparation shows with the right kidney the bladder and the right ureter. A most careful search at the time of the post-mortem examination failed to find any trace in the body of the left kidney or ureter, the right suprarenal capsule was normal in appearance and situation and perhaps slightly enlarged, the right renal artery had normal characteristics; the left was scarcely thicker than a stout thread, and was lost in the tissue of the left renal region. The right ureter was quite normal; no left ureter could be found after careful search. The patient was a boy, age 11, who suffered from morbus coxarius, complicated by tubercular disease of the lungs."

The case and specimen described above illustrate single kidney due to the congenital absence of one organ.

The following cases show how (b) *one kidney may atrophy* or become functionally inactive, either as a consequence of want of growth, or from disease in early life:

## CASE 10.

*Extreme atrophy of the left kidney with double pelvis but single ureter.*<sup>2</sup>

I have no details of the post-mortem examination in this case. The kidney tissue is almost completely destroyed, and the whole organ is about the size of a walnut. The pelvis is branched, and there is no hilum, the upper limb of the pelvis springs from the inner and upper aspect of the atrophied organ, while the lower limb arises from the lower border

<sup>1</sup>Glasgow Royal Infirmary Museum, Series VII., No. 8a.

<sup>2</sup>Glasgow Royal Infirmary Museum, Series VII., No. 9.

of the kidney. Both limbs unite about one and a half inches below the level of the kidney, each branch is of sufficient size to admit the little finger, and after uniting form a channel three-quarters of an inch in diameter. Below this the pelvis gradually narrows and forms a ureter which is a little wider in lumen than normal. In the preparation the vessels have not been preserved (see Fig. 9).

### CASE 11.

*Atrophied kidney, the renal tissue being almost entirely replaced by fat.<sup>1</sup>*

The patient from whom this specimen was removed was under my care in 1887. He suffered for many years from chronic cystitis, and ultimately died from cardiac disease complicated with passive hyperaemia of the lungs.

At the post-mortem examination the right kidney was found to be in a state



FIG. 9.



FIG. 10.

<sup>1</sup> Glasgow Royal Infirmary Museum, Series VII., No. 13.



of moderately advanced chronic interstitial nephritis, but up to the time of his death there were no symptoms pointing to renal incompetency. The kidney weighed ten ounces. The left kidney, as represented in Fig. 10, weighed half an ounce, very little renal tissue could be found in the mass, and what remained was completely embedded in firm fat. In this case the fat appeared to have developed outside the kidney, pushed its way into the interior of the organ by the hilum, and so spread towards the periphery of the organ.

The following specimen was placed in the Museum by Dr. J. Lindsay Steven, and he has allowed me to make use of it:

#### CASE 12.

*Atrophy of the right kidney with compensatory hypertrophy of the left kidney, disease of the suprarenal capsules.*

The following is Dr. Steven's note in the Museum Catalogue:

"Both kidneys are preserved, the right only weighed one ounce, the left seven and a half ounces. The organs were obtained from the body of a man suffering from spinal caries. The small right kidney was embedded in a mass of adipose tissue, and at its upper extremity there was a small cavity with smooth walls the size of a hazel nut filled with pultaceous material. The ureter of this kidney was considerably thickened, and its lumen was practically obliterated. The urinary bladder was much hypertrophied. The left suprarenal capsule was enlarged and was converted into a cream-coloured structure, but little tissue of normal appearance remained. The right suprarenal presented similar appearance."

The left kidney was healthy. Fig. 11 shows the atrophied kidney entire and on section, also the healthy kidney.

In the Royal Infirmary Museum there are many other specimens illustrating atrophy of the kidney as a consequence of disease.

Bright's disease and tubercular lesions are undoubtedly the most frequent causes of wasting of the kidney, and it is not uncommon in very chronic cases of interstitial nephritis to find

both kidneys weigh less than two or two and a half ounces. Such cases are, however, beyond the scope of this paper.

Again, renal atrophy as a consequence of obstruction to the ureter or from endarteritis, cannot be considered at present. It is to cases of congenital atrophy, or wasting of the kidney in early life, that we desire more especially to direct attention, and the cases described above appear to come under this category.

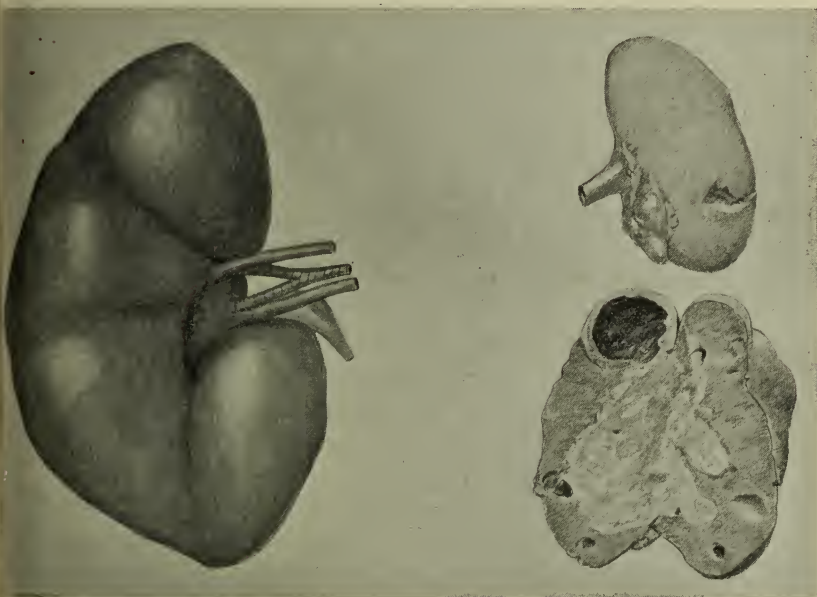


FIG. 11.

We may now consider some general questions connected with "single kidney" whether due to congenital defect or to complete atrophy of the neighbouring organ. It is of interest to observe that "single kidney" is not peculiar to the human subject, but has been seen in the lower animals also. Sutton, amongst others, states that this condition occurs in such animals as hens, horses, and sheep, and I have observed it in one instance in a calf. In these animals, as in men, the single kidney has been observed to have undergone increase in

bulk. The following points in connection with single kidney may be considered :

- (a) Duration of life of the individual.
- (b) Size of the kidney, compensatory hypertrophy.
- (c) Form, position, and side affected.
- (d) Sex and age of the individual.
- (e) Liability of a single kidney to disease.
- (f) Condition of the kidney, ureters, and vessels on the affected side, and on the side of the single kidney.
- (g) Malformation of the other organs.
- (h) Position of adrenal body.

(a) *Duration of life of the individual.* The absence of one kidney, especially when compensated for by augmentation in size, and by increased functional activity of its neighbour, does not seem to seriously influence the duration of life, so long as there is sufficient renal tissue left in the remaining organ to fulfil the function of life, as doubtless we are endowed, in the normal state, with considerably more renal tissue than is necessary for even active and vigorous life.

In the post-mortem room kidneys containing very little active secreting tissue are frequently found in the bodies of individuals who have, as far as is known, never suffered from any symptoms of renal insufficiency.

The following table shows the age at death of 17 cases of single kidney when death occurred after the age of 60 years was past :

8 persons died between 60-65 years.			
1	”	”	65-70 ”
4	”	”	70-75 ”
2	”	”	75-80 ”
2	”	”	over 80 ”
<hr/>			
17			

It can be easily understood, however, that in an individual with only one kidney, if that kidney becomes affected by any serious malady such as obstruction to the ureter, thrombosis, or any local inflammatory infection, the risk to life is greatly

increased by the existence of only one organ. In single kidney compensatory hypertrophy is the rule when the individual survives through the term of infancy, but even in the foetus considerable enlargement of the kidney has been seen. Morris mentions an instance of this in "a well-formed foetus born at full time," where "a right kidney only was present, and was twice its natural size; the ureter was much dilated."

(b) *In estimating the degree of compensatory hypertrophy* in recorded cases, care must be taken to exclude instances where the single kidney has become enlarged by disease; for instance, Morgagni describes a case where one kidney was functionally inactive, while its neighbour was ten times the normal size, and he mentions another case where a single kidney weighed 35 pounds. Again, Rhodius<sup>1</sup> records a case in which a kidney was so enlarged as to give rise to the suspicion of pregnancy. Eustachius, Vesalius,<sup>2</sup> Poupart,<sup>3</sup> Perrin,<sup>4</sup> Breschet,<sup>5</sup> and other old writers have recorded similar cases, in all of which it is very evident that the enlargement was due to disease rather than to a true hypertrophy of the organ. It may be said that when the single kidney is increased to much more than twice the normal size the enlargement is not entirely due to compensatory hypertrophy.

In true compensatory hypertrophy the kidney is found to be homogeneously enlarged in all its parts, and seldom if ever weighs more than two normal kidneys. Take for example other organs. Sometimes hypertrophy occurs in cases of congenital non-inflation of one lung, the neighbouring organ being increased in bulk, so also in the liver, when one portion becomes atrophied another may undergo hypertrophy. So many cases of compensatory hypertrophy in single kidney have been recorded that it is impossible to mention more than a few of them, but for the sake of reference I may give the following :

<sup>1</sup> Rayer's *Maladies des Reins*.

<sup>2</sup> *De Corporis Humani fabrica*, lib. v., cap. 10.

<sup>3</sup> *Histoire de l'Academie royale des Sciences*, Paris, année 1700, p. 35.

<sup>4</sup> *Journ. de Méd. de Chirurg. et de Pharmac.*, Tom. XIII., Novembre 1760, p. 431.

<sup>5</sup> *Medico-Chirurgical Transactions*, Vol. ix., 1818, p. 437.



Duckworth,<sup>1</sup> Macdonald,<sup>2</sup> Palma,<sup>3</sup> Brackenburg,<sup>4</sup> Northrup,<sup>5</sup> Davies,<sup>6</sup> Pollock,<sup>7</sup> Hewett,<sup>8</sup> Gubbin.<sup>9</sup>

On the other hand, it does not always follow that because one kidney is undeveloped or functionally useless the other organ must be considerably enlarged. Instances of single kidney, normal in size, have been seen by Turner,<sup>10</sup> Mayor,<sup>11</sup> Hamy,<sup>12</sup> Bostrom,<sup>13</sup> Brown,<sup>14</sup> and many others.

(c) *Position, form, and side affected.* In the absence of one kidney the remaining organ may (as in Fig. 8) occupy its normal position in the loin. This is usually the case in atrophy of one kidney from disease. Dr. P. W. Macdonald<sup>15</sup> described a case in which the right kidney and ureter were absent, while the left kidney was normal in position, and had a normal ureter entering the bladder in the ordinary situation. Similar cases have been described by Gubbin, Peacock, Lorain, and Gruber. Single kidney, when due to want of development of its neighbour, is more likely to be misplaced and altered in form.

In many cases, however, the single kidney remains normal in shape as well as natural in size, and, even in those cases where there is considerable hypertrophy, the renal form is strictly maintained, the organ being simply increased in all its dimensions. Indeed, alterations in form are not common. In some cases, however, the organ is much elongated, in others disc-shaped, angular, or relatively thickened, and not uncommonly lobulated. Dr. M. Watson<sup>16</sup> described a case of

<sup>1</sup> *Pathological Society's Transactions*, Vol. xx., p. 232.

<sup>2</sup> *Lancet*, May 30th, 1885.

<sup>3</sup> *Präger Med. Wochenschr.*, 1891, xvi. Jahrg. No. 33, p. 380.

<sup>4</sup> *Lancet*, London, 1891, Vol. II., p. 869.

<sup>5</sup> *Medical Record*, New York, Vol. xxxii., p. 608.

<sup>6</sup> *British Medical Journal*, 1885, Vol. II., p. 397.

<sup>7</sup> *Lancet*, 1863, Vol. II., p. 622.

<sup>8</sup> *Lancet*, 1863, Vol. II., p. 622.

<sup>9</sup> *British Medical Journal*, 1883, Vol. I., p. 115.

<sup>10</sup> *Edinburgh Medical Journal*, February, 1865, p. 687.

<sup>11</sup> *Bulletins de la Société Anatomique de Paris*, 1876, p. 592.

<sup>12</sup> *Journ. de l'Anatomie et de la Physiol.*, 1884, p. 193.

<sup>13</sup> *Beiträge zur Pathol. Anat. der Nieren*, Heft I., 1884, p. 36.

<sup>14</sup> *Journal of Anatomy and Physiology*, Vol. xxviii., p. 198.

<sup>15</sup> *Lancet*, May 30th, 1885.

<sup>16</sup> *Edinburgh Medical Journal*, Vol. II., 1874, p. 13.

congenital absence of one kidney, in which the remaining organ was normal in size but circular in form, the surface was distinctly lobulated, and the kidney was situated close to the brim of the pelvis.

Polk<sup>1</sup> also describes a case of single kidney where the organ was displaced into the iliac fossa, while Marzolo<sup>2</sup> records an instance where the right kidney was found lying on the right sacro-iliac synchondrosis. Weisbach<sup>3</sup> and Lombroso<sup>4</sup> publish instances in which misplaced kidney was associated with other abnormalities. The side most frequently affected is the left, especially in male subjects; in the female the right and the left kidneys are equally liable to the malformation.

(d) *The influence of age and sex.* The abnormality is found twice as often in males as in females, a circumstance which may be accounted for by the fact that necropsies are more often procured in the former sex than in the latter. About 10 per cent. of the specimens published were met with in the body of the foetus, or in newly-born children, and, in most of these cases, the anomalous condition of the kidney was associated with some other congenital deformity, such as imperforate anus, deformities of the bladder, uterus, ovaries, etc.

In individuals who have lived, notwithstanding the deformity of the kidney, there is nothing remarkable to note regarding their age at the time of death, the mortality being almost equally distributed up to 60 years of age; over that age, as already shown, seventeen cases are recorded.

(e) *Liability to disease in single kidney is marked.* Chronic nephritis, renal calculus, tubercular disease, hydronephrosis, pyonephrosis, and abscess being the most common maladies met with. Morris<sup>5</sup> says: "Probably, as has been above stated, there is a tendency to chronic albuminuria in early or young life in persons with one kidney atrophied. When only one kidney exists, and that an "unsymmetrical" organ, there would seem to be a considerable disposition to renal calculus.

<sup>1</sup> *Lancet*, 1883, Vol. I., p. 514.

<sup>2</sup> *R. Ins. Veneto di Sc. Elettore*, 1879.

<sup>3</sup> *Wiener medicinische Wochen*, 1867, No. 2, s. 20.

<sup>4</sup> *Gazzetta Medica Italiana*, February, 1860.

<sup>5</sup> *Diseases of the Kidney*, p. 100.

Of the twelve cases of "unsymmetrical" kidney collected by Mosler, death was due more or less directly to calculus in the pelvis or ureter in nine of them; in the other three, cancer of the bladder and rectum involved the ureter; nephritis, and the consequences of obstruction due to severe congenital phymosis, were respectively the causes of death. In the case of cancer (Tulpius), a calculus had been passed per rectum in early life, and there was an opening from the ureter into the rectum through which part of the urine escaped."

I have collected eight cases of "single kidney" in which calculus was present. These were published by Rhodius,<sup>1</sup> Jobi,<sup>2</sup> Rokitansky,<sup>3</sup> Rayer,<sup>4</sup> C. Julia Fontenelle,<sup>5</sup> Everard Home,<sup>6</sup> Sylvaticus.<sup>7</sup>

Chronic tubercular and interstitial nephritis is also very common, a few cases of hydronephrosis have been recorded, and one or two of tubercular disease, pyonephrosis, and abscess.

(f) *The condition of the kidney, ureters, and bloodvessels on the affected side.* In cases of congenital absence of one kidney the ureters and renal vessels on the affected side are absent, or only represented by a cord of fibrous tissue, and in all cases where a rudimentary ureter has been found, the opening into the bladder has been obliterated. Indeed single kidney due to want of development may be distinguished from that caused by disease and atrophy by the condition of the ureters and the bloodvessels.

When "single" kidney is the result of disease the condition of the diseased kidney varies very considerably, it may be represented only by a mass of fibrous tissue, a small congeries of cysts, or a nodule of fat. Sometimes the kidney is very small and occasionally lobulated; there may be remnants of

<sup>1</sup> *Mantissa Anatomica, Observatio*, xxxii., 1661, p. 21.

<sup>2</sup> à Meek'ren, *Observationes Medico-Chirurgicæ*, Amstelodami, 1682, cap. xl., p. 169.

<sup>3</sup> *Lehrb. der Pathologischen Anatomie*, Bd. III., 1861, s. 317.

<sup>4</sup> *Traité des Maladies des Reins*, Tome I., 1839, p. 404.

<sup>5</sup> *Archives Générales de Médecine*, Tome II., 1824, p. 517.

<sup>6</sup> *Practical Observations on the Treatment of the Diseases of the Prostate Gland*, London, 1811, Vol. I., p. 68.

<sup>7</sup> Cited by Lieutand, *Historia Anat. Med.*, Tome I., p. 284.

renal tissue remaining, and the ureters may be either occluded, patent, or even dilated. The appearance of the wasted kidney depends upon the causes of atrophy, which are either sudden and complete obstruction to the passage of urine from the pelvis, or obliteration of the renal artery at an early period of life. Frequently we meet with greatly wasted kidneys as a consequence of disease late in life, as for example in tubercular lesions, or in chronic inflammatory affections attacking one kidney only. These, however, do not come within the scope of this paper.

The pelvis and ureter of the "single kidney" are seldom much altered, and are never double, as has been described by some authors. Cases of a kidney provided with double pelves, double ureters, extending to and entering the bladder at different points, must be looked upon as examples of "fused kidney" rather than of true "single kidney." In many congenital cases, however, the arteries and veins are anomalous in their distribution, and as might be expected are collectively larger in size than normal.

Dr. M. Wilson<sup>1</sup> describes a case of congenital absence of the right kidney where the left organ was enlarged, circular in form and lobulated on the surface, and situated close to the brim of the pelvis, in front of the common and external iliac arteries of that side, with which it was in contact. Its duct, which was enlarged at the hilus, so as at first sight to resemble a cyst, gradually narrowed, but continued to be of greater calibre than usual throughout its course, except at the point of entrance into the bladder, where it assumed the normal size. The left renal artery came off from the point of bifurcation of the aorta, passed obliquely downwards and outwards, resting on the front of the left common iliac artery, and entered the upper extremity of the kidney, having previously divided into two branches. Dr. W. F. Menzies<sup>2</sup> describes a case of "single kidney," in which he states that the arterial supply was as follows:

"Just above the bifurcation of the aorta a branch was given off from the anterior aspect, and ran to the inferior

<sup>1</sup> *Edinburgh Medical Journal*, Vol. xx., Part i., p. 13.

<sup>2</sup> *Journal of Anatomy and Physiology*, Vol. xxi., p. 111.



internal corner of the kidney, entering it about a quarter of an inch from the edge of the posterior surface. From the right common iliac a third renal artery took its origin, and entered the organ in close proximity, but inferior to the former. The middle and inferior sources of supply were long straight vessels of similar lumen to the superior."

Similar anomalies of the circulation in "single kidney" have been noticed by Hebb,<sup>1</sup> Strube,<sup>2</sup> Macdonald Brown,<sup>3</sup> Macdonald,<sup>4</sup> Duckworth,<sup>5</sup> Th. Tourtual.<sup>6</sup>

(g) *Malformation of other organs, such as the rectum, the bladder, the uterus, the vagina, and the ovaries*, frequently accompany congenital defects in the kidney. This is not to be wondered at when we remember the close embryonic relationship of these parts, but this is a subject which is rather beyond the scope of this paper.

(h) *The position of the adrenal body on the affected side* varies considerably. Sometimes where the kidney is small or altogether wanting, the adrenal body is natural in size and normal in position; on the other hand, however, commonly the adrenal body is misplaced, and undoubtedly in a few instances may not be present; or again, the "single kidney" may have two adrenal bodies, as in a case published by Liebmann,<sup>7</sup> where a "single kidney," lying in the pelvis, had two adrenals associated with it. Brumer<sup>8</sup> states that in forty-eight cases of "single kidney" which he had collected the adrenal bodies were only absent in five.

3. *Absence of both kidneys* is found in the lower grade of monstrosities only, and, according to Beclard, this anomaly is most frequently met with in acephalous monsters. Chaussier<sup>9</sup>

<sup>1</sup> *Transactions of the Pathological Society of London*, 1885, Vol. xxxvi., p. 281.

<sup>2</sup> *Über Congenitale Lage- und Bildungsanomalien der Nieren*. Virchow's *Archiv.*, Bd. 137, 1894.

<sup>3</sup> *Journal of Anatomy and Physiology*, Vol. xxviii., p. 197.

<sup>4</sup> *Lancet*, 1885, Vol. i., p. 979.

<sup>5</sup> *Transactions of the Pathological Society of London*, Vol. xx., 1896.

<sup>6</sup> *Zweiter Anatomischer Bericht u. s. w.*, Munster, 1833, S. 69.

<sup>7</sup> *Centb. für Chir.*, 1887.

<sup>8</sup> Virchow's *Archiv.*, Vol. lxxii., p. 344.

<sup>9</sup> *Bull. de la Faculté de Méd. de Paris*, 1810, p. 35.

showed a foetus in which the urinary bladder, kidneys, and uterus were entirely absent, and Mayer<sup>1</sup> also published an example where the same organs were wanting. These cases may be of great interest from the embryological stand-point; and from the physiological side they are also of interest, as illustrating that the most important functions of life may be preserved in utero, without the presence of any renal tissue; but they are of no practical value to the surgeon.

## II. VARIATIONS IN FORM AND SIZE.

1. *General Variations in Form, — Lobulation.* Slight changes in shape from the typical normal kidney are by no means uncommon, and in more marked instances the organ may be elongated so as to become sausage-shaped, or it may be increased in thickness and globular in form, resembling the shape of the kidney in the foetus. In a few cases the kidney has been found to assume the discoid shape. These alterations, from what we may assume as the normal type, are often unassociated with any other anomaly; but when an abnormal condition exists, such as malposition of the kidney, atypical distribution of vessels, or malformations of other genito-urinary organs, then lobulation of the kidney is more frequent in occurrence, and more marked in degree. In the foetus and in young children slight lobulation is seen, but usually after the first year of life the lobules become fused, and are no longer apparent, unless in exceptional cases. In some of these the separation of the lobules may not be very distinct on the surface of the organ, but if a vertical section of it be made the original lobulated condition of the gland is seen. The persistence of this foetal condition is generally more marked at the anterior than at the posterior aspect of the kidney. A section of the kidney shows the medullary substance arranged in wedges, which form the pyramids, separated from one another by the columns of Bertini. These pyramids correspond to the embryonic lobules of the kidney, though several lobules may fuse together in one pyramid.

<sup>1</sup> *Journal des Progrès*, Tome IV., p. 281.

2. *Hypertrophy of one kidney.* Hypertrophy of one kidney is not often met with independently of some condition which has produced a functional weakness of its fellow.

Hypertrophy of both kidneys is, however, often seen in cases of diabetes insipidus, and perhaps also in diabetes mellitus.

Enlargement of one kidney only may however occur independently of any functional inactivity or structural defect of its neighbour. The kidney may go on increasing in size beyond the normal limit, just as we may have excess of growth in one limb, or undue growth of individual fingers, or toes, of the tongue, the larynx, or the lower jaw.

### CASE 13.

*Simple hypertrophy of the left kidney only, right kidney normal in size and appearance.*

At a post-mortem examination upon a man 36 years of age, who died from fracture of the skull, I found the right kidney to be normal in weight,  $6\frac{1}{2}$  ounces, while the left weighed  $10\frac{3}{4}$  ounces. The man was of average height, and weighed  $11\frac{1}{4}$  stones. Both kidneys, on microscopic examination, were found to be typically healthy, with the exception of the histological elements of the left kidney which were uniformly enlarged, as has been observed in cases of compensatory hypertrophy.

3. *Fusion of two kidneys.* (a) Horse-shoe kidney; (b) sigmoid kidney; (c) disc-shaped kidney. The amount of fusion that takes place between two kidneys varies greatly. We may have the two organs united together across the vertebrae, at their lower extremities, by a narrow, thin, and flat isthmus, which may be formed of connective tissue only, as illustrated in Fig. 12, or the union may be made up of kidney parenchyma; these are the lowest grades of coalescence, and from these we meet with all degrees of fusion until we reach a condition where the two kidneys become completely incorporated in one another, so as to form either one disc-shaped organ (Fig. 17), generally situated in the middle line,

or an elongated body on one side of the spine—the sigmoid kidney (Fig. 16); but in fused kidney, however unshapely the renal mass may be;—the renal form may be entirely lost on both sides; the hilum may be absent; the pelvis may be distorted; and the bloodvessels most irregular in their distribution;—there is still one feature in all its varying forms, namely, that they all possess evidence of two ureters, and not one only, as in true examples of single kidney.

We will first consider the lower degrees of fusion, and afterwards will give instances where more complete incorporation of the two organs has taken place.

(a) *Horse-shoe kidney* is the most common form of fusion. The two organs are joined together at their lower ends, sometimes by a simple band of tissue, as for example in Figs. 12 and 13. In other instances the union is more complete, while the renal form of the two lateral segments may not be retained, as in Fig. 14. Or again, as in Fig. 15, not only may the renal outline be considerably distorted, but there may also be marked lobulation, as well as anomalous distribution of the bloodvessels, or deformity of the pelvis and ureters.

#### CASE 14.

*Horse-shoe kidney, united by an isthmus of fibrous tissue at the level of the bifurcation of the aorta. Renal form well retained.*<sup>1</sup>

Horse-shoe kidney from the body of a man who died of pneumonia; the isthmus which unites the lower ends of both kidneys to one another is about 1 inch broad, and is situated in front of the bifurcation of the aorta; that vessel is unusually small in size. The right ureter arises from the pelvis by two distinct channels, and passes downwards in a groove, which is more distinctly marked than the corresponding one on the left side. The left ureter occupies a similar position, but the pelvis from which it arises is almost normal in form.

The blood supply is by five arteries, which pass off directly from the aorta. Two arteries supply the right segment, while

<sup>1</sup> Glasgow Royal Infirmary Museum, Series VII., No. 3.



the left is supplied by three. Considering the anomalous distribution, the arterial supply is wonderfully symmetrical.

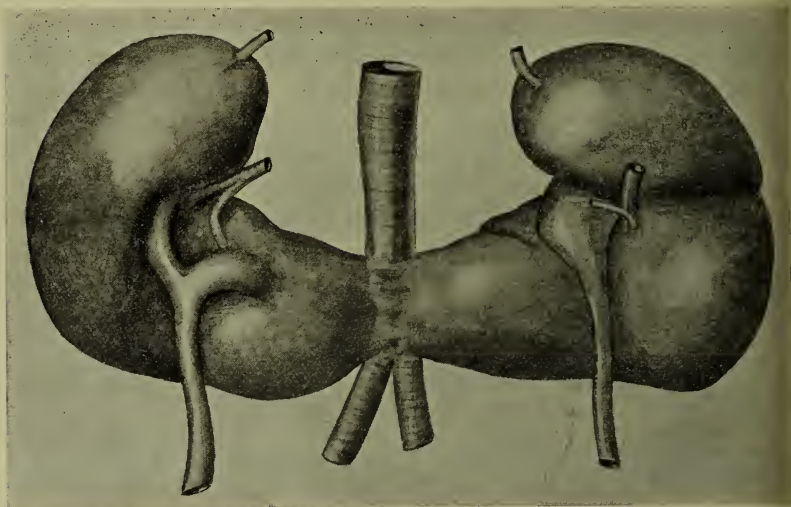


FIG. 12.

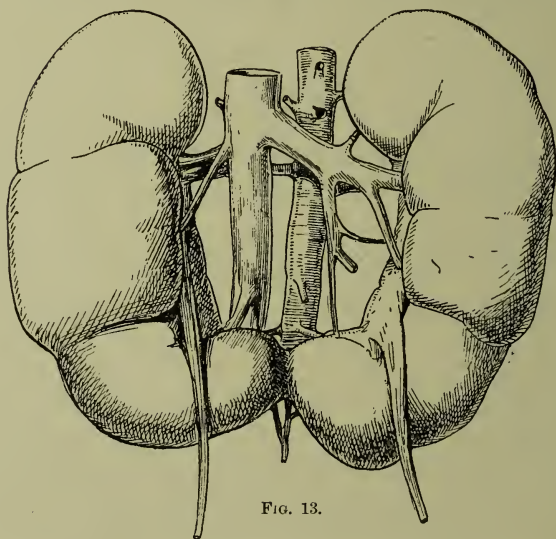


FIG. 13.

On both sides an artery passes directly to the upper and convex aspect of the kidney, while the other arteries pass into the

kidney at the hilum. In the specimen the veins have not been preserved (Fig. 12).

Drs. Sutherland and Edington published in the *Glasgow Medical Journal*, Volume XLIX., page 89, an example of horse-shoe kidney, where the departure from the normal is even less than in the case just referred to. In their case the two kidneys are united by an isthmus of renal tissue which measures 1.3 cm. vertically, and 3 mm. antero-posteriorly. Both kidneys, however, are distinctly lobulated (Fig. 13).

#### CASE 15.

*Horse-shoe kidney with lobulation and complete fusion of both kidneys  
malformation of pelvis, and anomalous distribution of bloodvessels.*

Both kidneys retain to some extent their renal form, and are united at their lower ends by a distinct lobule, which is

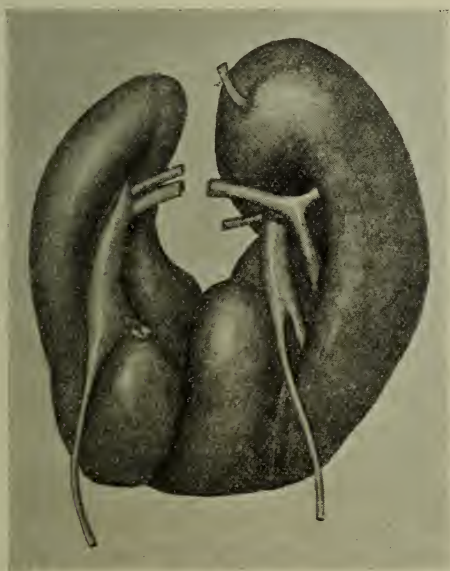


FIG. 14.

marked off by two deep grooves, on the right side the pelvis is not greatly malformed, but on the left it is abnormally small,

and is separated into two distinct branches, one passing to the upper, the other to the lower part of the organ. The right segment receives one artery, while the left is supplied by two, one entering at the hilum; the other close to the upper end of the kidney. Both renal veins pass out at the hilum (Fig. 14).

#### CASE 16.

*Horse-shoe kidney with complete incorporation of the two organs. Lobulation of both segments, the ureters deformed, and anomalous distribution of the bloodvessels.*<sup>1</sup>

The two kidneys are completely united at their lower ends, and the whole renal mass although lobulated is, roughly speaking, uniform in diameter, and in this respect contrasts with the previous specimens.

When removed from the body the mass weighed  $15\frac{1}{2}$  ozs. The arteries, which are small in size, sprang direct from the aorta, and the veins passed to the vena cava direct. On the right side three arteries enter the kidney on its upper aspect, while the left segment is supplied by an artery which enters the deformed hilum on the right side. Three venous trunks unite to form one vein before the blood is emptied into the vena cava, while on the left side one vein only leaves the kidney from the hilum. On the right side the pelvis is divided into three distinct branches, which unite, at the lower limit of the horse-shoe, to form the right ureter. On the left side the pelvis is also segmented into three parts, forming roughly with the ureter the appearance of a St. Andrew's cross. The ureter passes downwards in a deep groove on the anterior aspect of the shoe-horse.

As a rule the horse-shoe kidney rests on both sides of the spinal column, but lower down than normal, the isthmus generally crossing the vertebral column about the level of the bifurcation of the aorta. The band of union is almost always at the lower extremity, so that the concavity of the horse-shoe presents upwards. Cases, however, have been

<sup>1</sup> Royal Infirmary Museum, Series VII., No. 4.

recorded where the union was found to be at the upper, in place of the lower, ends of the organ. It has been already shown that the bond of union between the two segments may be slight, or may be very intimate. In the former, the blood-vessels, pelves, and ureters seldom depart much from the normal in their number or distribution; but when the binding of the two organs is very complete, the auxiliary struc-



FIG. 15.

tures also are markedly anomalous. This circumstance may raise the question whether or not the anomalous distribution of vessels may be regarded as a cause of the malformation of the kidney. The pelvis may be divided into several separate cavities, which unite to form the ureter some distance from the hilum. Monquiot<sup>1</sup> publishes a case where a kidney was placed transversely across the lumbar vertebrae, and had four pelves, four ureters, and as many arteries and veins. Whatever the other deformities may be the ureters seldom

<sup>1</sup> *Journal des Savants*, 1878, Mai 16me.



pass behind the renal mass. Durham,<sup>1</sup> however, describes a case in which the ureters passed behind the organ. The united mass weighed  $13\frac{1}{2}$  ozs., and was formed by the union of the lower extremities. The structure of the kidney is described as normal.

Sutherland and Edington describe an interesting example of horse-shoe kidney, in a male child, where there was a pyonephrosis limited to the left segment. On this side the pelvis was greatly dilated, and there were cavities representing dilated calices, which largely replaced the renal tissue and still contained remains of pus. The left half of the isthmus showed a similiar lesion; the right side of the specimen and the corresponding portion of the isthmus were normal.

Morris<sup>2</sup> describes and illustrates a most unusual form of fused kidney, and one with which I am not familiar. The two kidneys lie together, as if the hilum of one kidney was placed against the outer convex aspect of the other. The following in his description of the specimen:

"The two kidneys formed an irregularly shaped mass which weighed 13 ozs., and was lying on the front of the promontory of the sacrum. It was not an ordinary horse-shoe, for the vessels and ureters were arranged most unusually. The central part of the mass was fissured by a sulcus, in which the ureter for the left kidney coursed downwards and the vein for the same upwards, passing into the vena cava just above the junction of the two iliacs. In the right half of the mass the ureters and vessels, instead of being situated centrally, were on its outer side; the ureter being in front of the vessels as in the left, and as is usual in fused kidneys. The arterial supply in each consisted of two or three arteries for each half of the mass about the size of radials derived from the common iliac arteries, and entered the lower part of each kidney. The suprarenal capsules were in their normal positions. The renal substance to the naked eye was healthy."

(b) *Sigmoid kidney.* Sigmoid kidney is an end to end fusion of the two organs. In this anomaly both kidneys occupy one side of the body only, but while the condition

<sup>1</sup> *Guy's Hospital Reports*, 1860, p. 407.

<sup>2</sup> *Surgical Diseases of the Kidney*, 1885, p. 96.

is unilateral it cannot be properly included under the term "single kidney."

The following specimen from the Museum of the Royal Hospital for Sick Children, given to me by Dr. Lewis R. Sutherland, illustrates very beautifully a typical sigmoid-kidney. I may quote his description of it in the *Glasgow Medical Journal* for February, 1898, p. 95:

"*Fusion of kidneys in a female child.* The fused mass, which measures 11·5 cm. in length, presents an elongated reniform outline, and is possibly formed by the superposition of one kidney on the other, as represented in the accompanying sketch (Fig. 16).

"The anterior surface of the mass is irregularly lobulated; the posterior surface is smooth. There are two distinct pelves, one above the other, each in its own hilum. The upper hilum presents antero-internally; the lower anteriorly.

"The ureters, which are of normal dimensions, pass downwards and outwards from the corresponding pelves, and lie in grooves on the anterior surface of the mass. The upper entered at the right, the lower at the left angle of the trigone. The bladder was normal. The vascular relations were not fully determined.

"The suprarenal bodies were normally disposed. An examination of the generative organs was not made. Microscopic examination of the fused mass shows normal renal tissue.

"The specimen was removed post mortem from a girl about 7 years of age. The mass occupied the right renal region, and was distinctly palpable in life (G.H.E.). There was no trace of renal tissue found on the left side.

"*Note.*—The appearances suggest an incomplete union of two kidneys—the smaller (lower part of the mass) representing

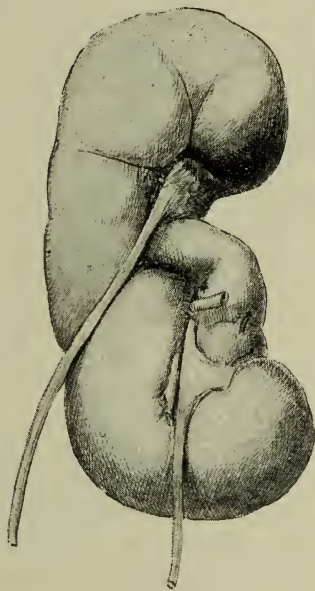


FIG. 16.

the left; the larger (upper part) the normally placed right kidney.

"From the relations of the lower ureter and pelvis inversion of the left kidney may possibly be inferred, as well as coalescence with the anterior surface of the inferior extremity of the right kidney. (Royal Hospital for Sick Children.)"

Almost precisely similar specimens are described by Dr. G. Broesike of Berlin,<sup>1</sup> and by Dr. A. Birmingham.<sup>2</sup>

Sigmoid kidney may be regarded as intermediate between horse-shoe kidney and disc-shaped kidney. The first mentioned fusion is very complete, while in the latter only the lower extremities of the organs are united. They differ also in the circumstance that the disc-shaped kidney and the horse-shoe kidney are most frequently placed in the middle line, while in sigmoid kidney one kidney is transferred to the opposite side where it is joined to the lower or inner part of the opposite organ. Probably sigmoid kidney is the rarest form of fusion.

(c) *Disc-shaped kidney.* Disc-shaped kidney is applied to those instances where incorporation of the two organs is very complete, as for example in the following cases—an illustration of which has been given to me by Drs. Sutherland and Edington :

"*Fusion of kidneys in a male infant. Hypospadias. Umbilical hernia sac.* The kidneys form a mass of approximately reniform outline, measuring 6.5 cm. vertically, 3 cm. laterally, and 2.5 cm. antero-posteriorly. The anterior surface shows distinct lobulation; the posterior surface is smooth (Fig. 17).

"The hilum faces anteriorly or antero-internally, a small amount of renal substance being situated towards the middle line behind. Emerging from the hilum are two distinct simple pelves, one above the other. This is corroborated on making a section of the mass. The lower ureter passes to the right side of the trigone, and is crossed anteriorly by the upper ureter on its course to the left side of the trigone.

"There are three sets of renal arteries: (1) an upper, entering the upper end of the hilum; (2) a lower, entering the lower

<sup>1</sup> Virchow's *Archiv.*, November, 1884.

<sup>2</sup> *Dublin Journal of Medical Science*, Vol. xc., p. 47.

end of the hilum; and (3) a third vessel supplying the intermediate parts. Branches 1 and 3 arise from the lateral aspect of the aorta, one above the other at the crossing of the renal vein. Branch 2 arises from the anterior aspect of the aorta to the right and below the origin of the inferior mesenteric artery. The renal vein is formed mainly by three tributaries emerging from the upper and middle portions of the hilum. It crosses the aorta in the normal situation of the left renal vein. There is entire absence of corresponding renal vessels on the right side.

"The specimen shows further the obliterated hypogastric arteries, and a portion of persisting urachus likewise obliterated. The bladder is normal (shown turned downwards and forwards in the figure).

"The specimen was removed post mortem from a male infant, aged 2 months who died of acute broncho-pneumonia.

"The 'fused kidney' occupied the left side. There was entire absence of kidney on the right side. The right suprarenal body, however, was present, as shown in preparation, but markedly flattened out on the under surface of the diaphragm. The left suprarenal body occupied its normal position. Both suprarenal bodies were supplied by vessels arising directly from the aorta, the left receiving in addition two twigs from the highest renal artery. The left suprarenal vein emptied into the left renal vein, the right suprarenal vein directly into the inferior vena cava. Microscopic examination shows a normal

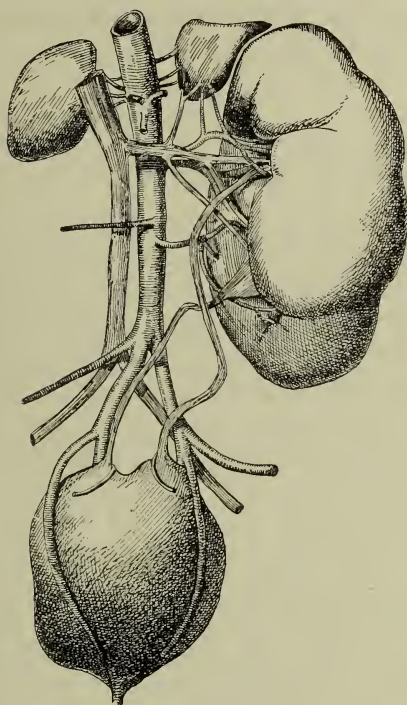


FIG. 17.



structure. The vasa deferentia, vesiculæ seminales, and testes were normal. There was fairly well-marked hypospadias. There was also a small umbilical hernia sac.

"*Note.*—The relations of the ureters to one another, and the origin of the lowest renal artery, are compatible with the possibility of the lower half of the mass, having occupied a position to the right of the median line. (Royal Hospital for Sick Children.)"

### C. VARIATIONS IN THE PELVIS, URETERS, AND BLOODVESSELS.

Malformation of the pelvis and ureters is fairly common, but these are generally of little importance.

The pelvis and upper two inches of the ureter are very frequently abnormal in cases of misplaced or malformed kidney, but even where the kidney is normal in position and in form the ureters may be deformed. These abnormalities have been already fully illustrated in the foregoing cases, in some of which the pelvis has been seen to be double or in several divisions, each of which may have a separate connection with the ureter.

The ureter may be double only for a short distance in its upper part, but in rare instances it has been found so throughout its whole course. We have seen a double ureter extending to within two inches, and cases have been described where it has extended to within one inch of the bladder.

Mr. John Wood<sup>1</sup> describes such a case. He says: "That in a male subject four ureters were discovered emerging from the hilum of each kidney, they united after proceeding about four inches towards the bladder forming a pelvis from which sprang the ureter proper. On section of one kidney the hilum was found occupied by a quantity of fat and connective tissue, embedded in which the ureters could be traced to the infundibula communicating with the calices and pyramids; thus there was no pelvis within the hilum, but the calices united to form infundibula of which these ureters seemed to form a continua-

<sup>1</sup> *Transactions of the Pathological Society, London, Vol. VII., p. 261.*

tion, and they became united in a pelvis some distance from the kidney."

Cases also have been described by Thomson, Coen, Richmond, Longé, Féré, Josso.

It may be safely said that no abdominal arteries are more irregular in their distribution than are those which supply the kidneys. They may vary in number, in their source of origin, or in the mode in which they enter the kidney. Cases have been recorded where both renal arteries have originated from a common stem arising from the front of the aorta, or the renal blood supply may be augmented by branches from the internal, external, or common iliacs, from the suprarenal artery, from the hepatic artery, or from the middle sacral.

The mode of entrance of the arteries also varies. They may pierce the kidney at the hilum, or may enter at any part of its surface, but most commonly abnormal vessels are found at the upper extremity of the organ. Again, the renal arteries may give off branches to the diaphragm, to the ascending colon, to the liver, or to the pancreas.

These irregularities in source, number, and distribution are well known, and have been fully described by Professor McAlister.<sup>1</sup>

Professor Joseph Coats showed a specimen at the Glasgow Pathological and Clinical Society,<sup>2</sup> which has some bearing upon the subject we are now considering. The specimen was one of hydronephrosis, where constriction of the ureter was caused by the pressure of an abnormal renal artery.

Professor Coats says, "The kidney has been supplied by two principal arteries. This artery has four branches, three of which pass into the kidney along the anterior border of the pelvis, whilst the fourth has passed rather downwards and backwards. In its passage this artery has encountered the ureter, and has crossed the latter shortly before its insertion into the apex of the pelvis. There is a deep groove produced by the artery, beneath which the ureter passes. The two rounded bulgings which here conceal the parts are, respectively, the dilated first part of the ureter and the apex of the pelvis. The

<sup>1</sup>*Journal of Anatomy and Physiology*, Vol. xvii., p. 250.

<sup>2</sup>*Transactions*, Vol. iii., p. 277.

dilated piece of ureter could be brought out by pulling on the ureter, and it was then seen that, at the place where the artery crossed the ureter, the wall of the latter was greatly thinned, the muscular coat being apparently destroyed."

We placed in the museum of the Royal Infirmary a peculiar abnormality of the kidney associated with a malformation of one ureter. The left kidney is about two inches longer than normal, and is divided by a deep groove into two distinct parts, the upper the larger, and the lower the smaller part, are each provided with a distinct pelvis and ureter, but the ureters join about two inches from the lower border of the organ.

## ON THE OCCURRENCE OF SMALL CHRONIC ABSCESS IN THE BREASTS OF DIABETIC WOMEN.

BY HECTOR C. CAMERON, M.D.,

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THAT diabetic persons are prone to the formation of carbuncle, boil, and limited suppuration in various parts of the body is a fact so well known as barely to require statement. But there is one situation in which very limited suppuration now and again occurs in diabetic women which deserves special attention, but to which nevertheless I have not seen special attention drawn. I refer to a small and extremely hard swelling occurring in the mamma which simulates very closely a scirrhus tumour, but is ultimately discovered to be a small chronic abscess. It sometimes contains in its interior a distinct slough, is always surrounded by great and well-defined induration, and, in consequence, always manifests the hard tumour-like character to which I have referred. The pus being in small quantity and contained in the midst of a little mass of induration, conveys only a very indistinct sense of fluctuation to the fingers. Indeed it is only likely to be detected if, being familiar with the facts which I am now narrating, and knowing the further fact that his patient is the subject of glycosuria, the surgeon is led to make a very close and critical search for it. The ailment is sure to raise the alarm of cancer in the patient's mind, but just as happens in cases of cancer, she may not consult a medical man for weeks or months after its discovery. Nevertheless, little apparent change occurs in it; it remains for long periods without material increase in size, and without any tendency to



travel towards the surface and to point. So far as I have observed, it is almost, if not entirely, devoid of pain.

I may illustrate these facts by narrating three examples of the ailment.

Some years ago I was asked by a medical friend to see his sister-in-law on account of two small but very hard lumps in one of her breasts. She had been conscious of their presence for a month or two, but was not quite clear as to their exact duration; they seemed to cause her no pain, but had naturally raised the suspicion that they might be of the nature of carcinoma. One was situated near the axillary border of the mamma, the other pretty close to the nipple, of which there was no retraction that was at all events marked. Neither of them was as large as a small-sized walnut. All the rest of the mamma, even that portion intervening between the two tumours was soft and natural in appearance and feeling. There was no puckering or other sign of attachment of the skin to either swelling. The lady, who was married but had never had any child, had been affected for a number of years with diabetes. Just before I saw her she had been in London, and had seen Dr. Matthews Duncan and Dr. Pavy, both of whom she had consulted before. Dr. Matthews Duncan was strongly of opinion, so the patient reported, that the disease was carcinoma, while Dr. Pavy expressed doubt on the point. Each tumour appeared to me to be extremely like a scirrhus, and the only circumstance which made me hope that this was not the case was the unusual one of finding two distinct and quite separate masses of scirrhus in the same breast. It was arranged that I should determine the real nature of the case by incision. All preparations were made for removal of the breast, if that were found necessary, and Professor Joseph Coats was present with a microscope to examine a fresh section of the tumour before I proceeded to the larger operation. The patient having been placed under chloroform, I incised the skin freely, and took out an elliptical slice of the mamma containing the whole of one of the tumours. I handed it to Dr. Coats, who cut into it, when some thick pus escaped from a cavity in the centre of the indurated mass. On removal of the other it was found to be in every respect similar in character. Our patient suffered

from constant and distressing vomiting for several days—an exaggerated form apparently of chloroform sickness—and became much weakened. She ultimately, however, made a good recovery; dying about a year afterwards, I think, of diabetic coma.

Not very long after this occurrence a middle-aged woman was sent into my female ward in the Western Infirmary of Glasgow with what was supposed to be a carcinoma of one mamma. The tumour was very hard and fairly well defined. She had not been conscious of much pain in it, and could give no very distinct idea of its duration, having accidentally discovered it only shortly before showing it to her doctor, who at once sent her on to me. It was situated somewhat to one side of the nipple, which was unretracted and natural in appearance. The skin over it was quite free and movable. It appeared to me to be probably a solid tumour and possibly a carcinoma. After the administration of chloroform I cut into the tumour and found that it consisted of a limited, well-defined mass of induration in the mamma, with a small central cavity filled with some thick pus. I cut out the whole indurated mass, and the patient made a good recovery. So like were the appearances in this case to those of that which I have just described, that I requested that the urine should be examined carefully. This was done with the result that a large quantity of sugar was found to be present.

The knowledge thus obtained in these two cases kept me right in expressing an opinion in reference to the nature of a mammary tumour, comparatively recently, in the case of the wife of a well-known gentleman in the west of Scotland, under the following circumstances. I received a message one evening to proceed to the country by an early train on the following morning to this gentleman's house. On arrival I was told by him that his wife had discovered a hard lump in one of her breasts and had spoken of it to him; and that, having consulted their doctor on the previous day, he had expressed the opinion, or at least the fear, that the lump was a malignant tumour. The nervousness and dread which arose in consequence in the minds of the lady and her family were the cause of the somewhat urgent summons which had been sent to me. They were

anxious to know at once, if possible, the true nature of the tumour, as well as what ought to be done. Before I went to the lady's bedroom her husband told me what I was quite ignorant of, although I had known the patient for some years and had visited occasionally in her house, that she had been known to have a considerable amount of sugar in her urine for some time. He added that this fact had not been mentioned beyond their own family circle, although known to a medical man who formerly attended the family and who had recently died; but "I tell you of it," he said, "lest you may deem it of importance in making up your mind as to whether any surgical operation should be recommended or not." The knowledge of the fact thus communicated put me on my guard. The tumour was a hard, well-defined but comparatively small one at the sternal end of one mamma, over which the skin was adherent but neither reddened nor puckered. There had been slight occasional but no constant pain in it. It was certainly very like a scirrhus; but my knowledge of the fact that the patient was glycosuric, and also of the clinical facts concerning other persons similarly affected which I have just detailed, made me examine it very critically, with the result that I thought I satisfied myself that there was some fluid in its central part. At all events, I communicated to the medical attendant and to the husband my hope that it might prove to be a suppuration; and it was arranged that I should return on the following day to test the matter. Accordingly, next day, I froze the overlying skin with ether spray and incised the tumour, with the result that a little thick creamy pus was evacuated and, on pressure being made, a considerable loose slough was expelled. There remained behind the surrounding induration; but ere long the cavity healed and the induration disappeared. The patient has had no further trouble from this source, and to all appearance continues in fairly good health.

These cases are all no doubt, as I stated to begin with, merely examples of the tendency of limited suppurations to occur in diabetic persons; but their particular anatomical situation, as well as their physical characteristics, make them of the greatest possible interest to surgeons from the point of view of diagnosis.

It must not of course be forgotten that diabetic women may suffer from carcinoma of the breast just as others do. I have myself removed the mamma and the contents of the axilla in the case of two such patients during the last twelve months.



OBSERVATIONS (CLINICAL AND BACTERIOLOGICAL)  
ON THE CIRCUMSTANCES OF OPERATIVE IN-  
TERFERENCE WITH MUCOUS MEMBRANES, WITH  
REFERENCE SPECIALLY TO THE URETHRA.

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THE results of certain observations which have occupied much of my spare time during the past few years are here given as so many statements of fact verified as fully as the difficulties surrounding them have permitted. No attempt is made to draw final conclusions on any or all of the points raised—the sources of fallacy are too numerous, and often too obscure; and, as explained below, the observations are incomplete, and are still being carried on. No bibliography of the subject is included. In the course of the investigation I had partially compiled one. Two things led me to abandon as useless labour the effort to complete it. These were, in the first place, the contradictoriness of the statements of the various writers, and, in the second, the obviously second-hand order of many of these statements. The observations detailed, therefore, are to be regarded as the expression of an attempt to reach the facts of the subject by an observer as far as possible unbiassed by previous statements. They are not, however, as already stated, given without the knowledge that fallacies may be present. So many sources of fallacy have become apparent that it is highly improbable that there may not remain still others.

The investigation has followed two lines: (1) Into the

possibility of sterilizing by one or other means the various forms of bougie and catheter in use. (2) Into the question of the presence or absence of bacteria in the urethrae, morbid and normal, into which in practice instruments have to be passed.

The results are given in semi-tabulated form. The cases are those of patients examined in the Western Infirmary, the Central Dispensary, the Children's Hospital, and private practice, and my own notes of the cases are much more full than the brief records produced here.

In the work I have been indebted for invaluable help to Mr. F. H. Riley, who has previously, in another matter, given me much assistance.<sup>1</sup>

The *Clinical Research Association* also have most carefully and exhaustively reported on a number of preparations and cultures submitted to them. To Dr. R. M. Buchanan, of the *West of Scotland Clinical Research Laboratory*, and to Dr. L. R. Sutherland, Assistant Professor of Pathology, Glasgow University, and to two other gentlemen whose names are not published, I owe hearty thanks for much valuable help. Finally, Dr. A. R. Ferguson, Assistant Pathologist, Western Infirmary, and Dr. Leslie Buchanan, of the Eye Infirmary, have lately been giving a large proportion of their time and skill to the completion of that part of the investigation which is still in progress. In the face of the very contradictory statements of various writers, it has been my endeavour, by submitting all doubtful matters to one or more of the gentlemen named—all of whom have a wide and accurate knowledge of practical bacteriology—to arrive at results which might be regarded as reliable. I thus feel a degree of confidence in the accuracy of the results stated, which dependence on my personal efforts alone could not have given.

## PART I.

With regard to the first part of the investigation—the sterilization of instruments—the following results were obtained :

<sup>1</sup>“The Aetiology and Treatment of Chronic Enlargements of Lymphatic Glands.” *Glasgow Medical Journal*, January, 1896.

## BOUGIES.

*Metal Bougies* may, of course, be sterilized by heat. They may also be sterilized by the same processes as are applicable to soft bougies, and observations on this point are quoted below.

*Soft Bougies*—red, black, and yellow “gum-elastic”—will not stand heating by any method to a temperature sufficient for sterilization. This statement is founded on numerous tests which I have applied to instruments supplied by different firms in Britain, America, France, and Germany, and applies to dry heat, steam, and boiling in water or oil. Occasionally a bougie is encountered which will survive a single not too prolonged boiling or steaming. Such an instrument is an exception, however, and but proves the rule, for repetition of the process is speedily destructive.

Professor Albarran some time ago introduced soft bougies (and catheters) covered with caoutchouc, which are, or were, stated to stand sterilization by boiling. For these I made inquiry through instrument makers in London and Paris, and was informed that they could be made for me, but were not now stocked, as their power of resisting heat was found to be easily exhausted. I have not therefore tested these, being influenced by the considerations that instruments both troublesome to obtain and costly, by reason of being specially made to order, and of short life, were not, whatever their merits otherwise, likely to be much in use. The following observations were made only on the ordinary red, black, and yellow “gum-elastic” bougies of every-day use:

I. *New gum-elastic bougies*—red, black, and yellow—of various shapes and different makers were tested in solutions of carbolic acid and perchloride of mercury.

Soaking for fifteen minutes in carbolic, 1 to 20, or for half an hour in carbolic, 1-40, or for an hour in perchloride of mercury, 1 to 1000, renders the surface of nearly all of them so sticky that the towel adheres in the process of drying, and the bougie becomes covered with fluff. If the bougie be permitted to lie for an hour or two in the air this fluff dries, and may be readily wiped off. After several soakings, however,

the surface becomes permanently dull and sticky and unfit for use. Occasionally a bougie is found which, for a time, will stand such treatment. That is the exception. The majority are affected as stated, and it is obvious that sterilization in this way is unfit for practice. In the first place it is impossible to wait for an hour or more till the bougie is sufficiently dry to be rubbed smooth for use. In the next place, to employ it while still damp and sticky is to sacrifice a bougie, for if there be germs in the urethra they will become embedded in the sticky surface of the bougie in such a way that it is difficult to conceive of their removal or destruction by any process not destructive of the instrument. Finally, even granting that such brief soaking will sterilize a soft bougie (and on this point I have not made sufficiently accurate tests to speak definitely), and that the average bougie may be used twice or thrice after it, the process is too costly for practice. Some other mode of sterilization is therefore necessary. Dr. Schimmelbusch in his *Aseptic Treatment of Wounds* says: "It is important that it should be known that a smooth" (red gum-elastic) "bougie or catheter can be made externally free from germs by mechanical means, rubbing it with a piece of sterilized gauze and warm water."

To test this I made the following experiments:

II. *Series of six soft gum-elastic bougies* which had been in ordinary use for from six to eighteen months. After use in cases of stricture these were washed with tepid water and soap, rinsed in cold running water, and dried with thorough light friction by sterilized gauze. Each bougie was then rubbed on the surface of slightly acid agar, and on the surface of slightly alkaline agar in tubes. *Results*: In one case, in an alkaline tube, on the fourth day, there appeared two small colonies, which proved to be a large white coccus, which was not definitely identified. In another alkaline tube, on the ninth day, there appeared a patch of penicillium. The other ten tubes remained sterile for over a month, the period during which they were under observation.

III. *Series of six soft gum-elastic bougies*:—soiled with pus from acute abscesses, washed with tepid water and soap, rinsed in cold running water, and carefully dried by friction



with sterilized gauze. Three of these were rubbed on alkaline agar, and three were stabbed into neutral gelatine. *Results*: All six tubes remained sterile for a month.

IV. *Series of six soft bougies*:—used in cases of stricture, washed with tepid water and soap, rinsed in cold running water, and dried with soft white towels which had not been sterilized, but which had come fresh from the laundry, where they had been boiled in the course of cleansing. The process of drying was completed by rubbing the instrument firmly from hilt to point several times with a fresh portion of the towel. Each bougie was then rubbed on slightly alkaline agar and on slightly alkaline glycerine agar. *Results*: All the tubes remained sterile for a month.

V. *Series of six steel, plated bougies*:—used in cases of chronic gleet, washed with soap and water, rinsed in cold running water, and dried with towels fresh from the laundry in the manner above described. They were then rubbed on plates of slightly acid gelatine and on plates of slightly alkaline agar. *Results*: Four of the twelve plates developed penicillium. The others remained sterile for a month.

VI. *Series of six soft bougies*:—used in cases of gleet, washed with soap and water, rinsed in running water, and dried with towels which had been sterilized by steam. Each bougie was then rubbed on neutral glycerine agar and stabbed into neutral gelatine. *Results*: One of the glycerine agar tubes yielded a sparse growth, appearing on the fifth day. This was pronounced by one bacteriologist to be *bacillus coli*, and by another to be *proteus vulgaris*. The other tubes remained sterile for a month.

In the foregoing experiments the water employed for washing was the ordinary gravitation water of Glasgow. No means were adopted for sterilizing it. The towels were from the laundry of the Western Infirmary and from two private laundries. The oil employed for lubricating was made up after the formula of Lund. The culture media were prepared in the usual way, and were kept previous to use for a time sufficient to exclude chances of impurity.

*Conclusions*.—It appears clear that ordinary careful washing of a soiled bougie followed by careful drying with gauze or

towel which has been sterilized by steam or boiled may be relied on to render the instrument sterile. The results of the experiments above detailed are practically uniform, for in series V. the fact that four out of the twelve cultures developed penicillium, a non-pathogenic mould, is probably to be explained by the fact that series V., unlike the others, necessarily consisted of plate cultures instead of tubes, plates being much less readily protected from aerial contamination. It seems, therefore, that it is unnecessary to have recourse to the use of carbolic or perchloride lotions which, as stated, rapidly destroy the instruments.

In practice there is a consideration which is of prime importance. Instruments must not be employed after their surface has become broken. Metal bougies on which the plating has become chipped or scratched, and soft bougies with chipped or cracked surface, offer sites for the lodgment of septic material from which it is not easily dislodged without still further destruction of the surface. Metal bougies may be replated. Soft bougies, however, once cracked cannot be repaired, and have to be discarded, and their life is shorter than that of the metal instrument. As indicated, treatment by carbolic or mercurial lotions is peculiarly destructive of them, and, by rendering the surface rough and broken, defeats its own purpose.

#### CATHETERS.

*Metal Catheters*, like metal bougies, may be readily sterilized by heat.

*Soft Catheters*.—The red “*rubber*” catheters, usually termed “*Jacques*,” which are composed of various compounds containing rubber, may be sterilized by boiling or steaming without in any way suffering. They may also be soaked for months in solution of carbolic acid (1 to 20) and perchloride of mercury (1 to 1000) without damage. An india-rubber catheter may also be used daily, and subsequently washed with hot water and soap, and put to soak in carbolic lotion for the remainder of the twenty-four hours for a period of six months without becoming unfit for use. These statements are based on ample actual and carefully noted tests which I have made, but which

need not be here given in detail. Two things are worthy of note. In the first place these statements refer to rubber catheters of a certain quality only. There are in the market catheters of red rubber composition, which may be of as good quality as, or better quality than, the others, but which rapidly deteriorate under repeated boiling. Certain firms supply these, and these only. In the second place *all* rubber catheters ultimately deteriorate to some extent after repeated boiling, the change in some being in the direction of brittleness, in others of pulpiness. Prolonged and repeated soaking in strong antiseptics has very little effect indeed, even when long continued, in producing deterioration.

By actual experiments I have satisfied myself that rubber catheters treated by boiling, efficient steaming, or soaking for four hours in the lotions above-mentioned, are rendered sterile, both internally and externally. As, however, few, if any, will be inclined to doubt this, detailed records may be omitted.

*Gum-elastic Catheters*—black, red, and yellow—of various forms and from various makers—have been tested as follows:

I. *Soaking in Antiseptic Solutions* of efficient strength.—Gum-elastic catheters are affected by this in the same way as bougies. In short, and without detailing the tests I have carried out, while nearly all varieties will stand brief immersion, no catheter I have been able to obtain will stand lengthened or repeated soaking such as is necessary for efficient sterilization. This method of sterilization is therefore, as in the case of bougies, impracticable.

II. *Soaking in Carbolyzed Oil*.—This is in no way harmful to gum-elastic catheters. At present I have lying in carbolyzed oil (1-40) five gum-elastic catheters which have been in it for over three months. They are in no way damaged. As a means, therefore, of preserving new catheters, or catheters previously sterilized, from aerial or other contamination it may be employed. As a means to be relied on for sterilizing soiled catheters, on the other hand, it fails. This is what might be expected in the light of Koch's experimental demonstration of the fact that antiseptic substances dissolved or suspended in oil are practically inert. To test the matter I made the following experiments:



(1) Black, gum-elastic, No. 6 coudé catheter of inferior make, *i.e.* with rough unfinished interior, saturated with pus from a large perityphlitic abscess, and subsequently wiped externally and allowed to dry in the air for six hours. The catheter was then placed, *end-down*, in carbolized oil (1-20), care having been taken that the oil had thoroughly displaced the air from the interior. It remained there eight days, at the end of which time it was removed on to sterilized gauze, and by means of a sterilized knife and forceps completely bisected longitudinally. The halves were then by means of the forceps thoroughly rinsed in warm water which had been sterilized by boiling. One half was then pressed face-down on the surface of neutral agar in a wide tube, and the other embedded in neutral gelatine. *Result:* The agar medium yielded a growth of bacillus coli and a small coccus. The gelatine yielded a growth of the same coccus. It may be observed that, on washing off the oil with the sterilized warm water, beads of dried pus could be seen plentifully adherent to the interior of the catheter, quite undissolved and unpenetrated by the oil.

(2) Red varnished catheter, No. 10, passed in a case of old prostatic cystitis and tied in for over four days. The instrument was then rinsed in warm water, wiped externally, and placed, *end-down*, in carbolized oil. After sixteen days it was removed and treated exactly as was the catheter in experiment No. 1. *Result:* Both halves yielded on slightly alkaline agar a mixed growth which was not fully worked out by subsequent culture, but which contained at least two germs—bacillus coli and a diplococcus. Red varnished catheters are made quite unfinished and rough in the interior.

III. *Turpentine, alcohol, and ether.* Nearly all varieties of soft catheter are singularly tolerant of *turpentine*. I have immersed red, yellow, and black catheters for weeks in turpentine without their sustaining any damage. On the other hand, no soft catheter I have been supplied with will stand the action of *alcohol* or *ether* for more than a few minutes without softening and cracking of the varnish. As, therefore, alcohol or ether is required for the thorough removal of the turpentine before use, cleansing by this means is impracticable.

IV. *Formol vapour* has lately been tried as a means of



sterilization. Through the kindness of Dr. Kay I some time ago obtained from Paris the most approved form of apparatus for the purpose. In it the catheters (or bougies) are placed on wire network shelves over a tray containing formol, and are shut in an atmosphere of formalin vapour by an air-tight cover for twenty-four hours or longer. With this apparatus I conducted the following tests :

(1) Catheter, No. 7, black olivary, of inferior make, *i.e.* with rough unfinished interior, saturated with pus from abscess of acute cellulitis, and dried for twenty-four hours. This was left in the metal case in the formol vapour (material supplied by a Glasgow firm, and employed according to the directions of two published articles) for forty-eight hours. It was then split lengthwise with a sterilized knife and embedded in slightly alkaline gelatine, in which, within three days, appeared a plentiful growth of staphylococci.

(2) Catheter, No. 10, black, coudé, of inferior quality, tied in for over twenty-four hours in a case of old cystitis from prostatic retention. This was rinsed in warm water and at once placed in the apparatus over formol (material obtained from a London firm) for three days. It was then split, and the internal surface impressed in neutral gelatine, where a mixed growth of bacillus coli and a coccus developed.

(3) Catheter, No. 6, yellow, olivary, well coated internally, repeatedly employed by a patient with old cystitis from stricture, and after use held under the tap and laid away in a towel. This was placed in the apparatus over powdered trioxymethylene (obtained from, and used according to directions supplied by, the makers of the apparatus) and kept there for forty-eight hours. It was then split and embedded in gelatine, and yielded a growth of a coccus which at first appeared to be a staphylococcus, but which subsequently showed evidence of fission in the manner of a diplococcus.

It is not necessary to detail certain other tests which I have carried out with the apparatus, and which have given very similar results. Unless there be some serious source of fallacy in my mode of procedure, there can be but little doubt that as a method of sterilizing really dirty catheters the process is quite unreliable.

The process is the most recently introduced method for sterilizing catheters and bougies. Its original claims to efficiency have been quoted and requoted by various enthusiastic writers. My results have been so absolutely disappointing that I should have felt tolerably certain there must be something wrong with my procedure, and should probably not yet have published these results but for one fact. I have recently found in the *Annals of Surgery*, August, 1896, a summary by Dr. Martin of the most recent experiments of the original manufacturer of the apparatus. The results of these experiments by no means bear out the early and very positive claims advanced for the method, and which have been so widely quoted. They correspond very closely with my own. The final results of the manufacturer's tests are summarized thus: "As the result of many experiments, ——— comes to the conclusion that formol and trioxymethylene are admirably adapted to the sterilization of bougies, but that in the case of catheters exposed to twenty-four or forty-eight hours' action there may be failure when small quantities of formol are employed, when the temperature of the surrounding atmosphere is low, or when the attempt is made to sterilize small catheters with very fine lumina or irrigating cystoscopes. It is probable that all these instruments could be thoroughly sterilized by a more prolonged exposure. This, however, is not practicable. It is essential, therefore, . . . not to attempt the sterilization excepting with catheters of large calibre exposed for twenty-four hours, or catheters of fine calibre and simple cystoscopes which have been previously washed for forty-eight hours." The results of my tests would seem to indicate that neither for large nor small catheters is the process of any value; and Dr. Martin, in the article quoted, appears to be essentially of this opinion, for the directions given for the process are that the instruments "*should be carefully washed with soap and water within and without*, and dried as nearly as possible before sterilization . . . then subjected to the vapour of formol for at least twenty-four hours . . . when required for use . . . taken out and immediately *submerged in weak antiseptic solutions*, biniodide of mercury, 1·25,000, answering very well." The italics are mine.

V. *Heat.* No variety of gum-elastic catheter, whether black, red, or yellow, will stand boiling, dry heat, or steaming in an ordinary sterilizer. This statement is based on a number of actual experiments which I have carried out with catheters of different varieties and makers. These experiments need not be here given in detail. Certain conclusions arrived at, however, may be mentioned. (a) Soft catheters are less speedily destroyed by heat than are soft bougies. This may be owing to the tubular form permitting of the escape of hot air and gases from the interior, and thus obviating the rapid blistering of the surface which occurs in bougies. (b) Not a few soft catheters will stand boiling or steaming once if not too prolonged. A few will even survive a second, and, at times, a third repetition of the process. Of all forms of soft catheter that which is most tolerant of heat is the old red varnished curved catheter. These observations, however, do not invalidate the general statement that soft catheters are more or less rapidly destroyed by heat applied in any of the three ways specified.

*Steaming the Interior of Catheters.* Various forms of kettle have lately been introduced, designed to drive steam from the spout through a catheter fixed on it, and thus sterilize the interior of the catheter. Various tests which I have carried out have led me to the conclusions that: (1) Under certain conditions the process is reliable as a means of sterilizing the internal surface of soft catheters. (2) Under only exceptional conditions can the process effect the sterilization of the exterior of a catheter. (3) When efficiently carried out the process tends, sooner or later, to be destructive of the catheter subjected to it.

With reference to the first conclusion arrived at I found that the conditions mentioned are two: (a) The *apparatus* must be properly designed. Four firms supplied me each with its own particular form of kettle. All four were similarly tested in the following way: A catheter was accurately fitted on the kettle spout, and in the eye of the catheter was placed a delicate thermometer. Two of the kettles raised the mercury to the boiling point of water, and kept it there indefinitely, as tested by three different thermometers. Of the other two



kettles one failed to raise the column to within  $2^{\circ}$  of boiling point, and the other failed to get the mercury within  $3^{\circ}$  of boiling point. The results varied imperceptibly with catheters of different calibre, and with tests of varying duration. (b) *Sufficient time* must be allowed for the steam to act. On this point I have made the following tests:

(1) *Black Coudé*, No. 8:—saturated with urine containing bacillus coli and diplococci in prostatic cystitis. The catheter was dried in the air for twelve hours. Its exterior was carefully cleansed with warm water and soap, and then with carbolic solution (1-20), care being taken to prevent anything entering the interior. It was then efficiently steamed for thirty minutes, split and embedded in slightly alkaline gelatine. *Result*: No growth occurred.

(2) *Yellow Coudé*, No. 10:—employed in the same case, and afterwards treated in exactly the same way, and finally efficiently steamed for two minutes, split and embedded in neutral gelatine. *Result*: Sparse growth of bacillus coli in both tubes.

(3) *Red Varnished Catheter*, No. 10:—employed in the same case, and subsequently subjected to the same treatment, and finally efficiently steamed for twenty minutes, split and embedded in neutral gelatine. *Result*: No growth occurred.

(4) *Yellow Coudé*, No. 12:—employed in the same case, subjected to the same after-treatment, and finally steamed for twenty minutes, split and embedded in slightly acid gelatine. *Result*: A colony of diplococci formed in the tube, containing one-half of the catheter. From the position of the growth I could not avoid the conclusion that it originated from the external aspect of the catheter. The necessity for preserving the interiors of these catheters from the action of the soap and water and the carbolic solution rendered the process of sterilizing the exteriors somewhat unsatisfactory.

(5) *Yellow Coudé*, No. 11:—employed in the same case, subjected to the same after-treatment and steamed for one minute, split and embedded in neutral gelatine. *Result*: Both halves yielded a growth of bacillus coli, and in the case of one-half it seemed perfectly clear that it first originated from the external surface.



In the face of this difficulty I attempted to test the matter in another way. A large, No. 16, black, olivary, gum-elastic catheter was fixed on the kettle, and in it were placed in succession six No. 1, black, olivary gum-elastic bougies along with a fine thermometer. The results got were as follows:

(1) Bougie smeared with purulent urine from a case of cystitis due to faecal fistula. (This urine swarmed with bacillus coli, diplococci, and staphylococci.) The bougie was not allowed to dry, but was at once placed in the catheter and efficiently steamed for thirty minutes. It was then removed, allowed to cool under glass, and embedded in neutral gelatine. *Result*: No growth occurred.

(2) Bougie treated in the same way, steamed for one minute, and embedded in neutral gelatine. *Result*: No growth occurred.

(3) Bougie treated in the same way, steamed for three minutes, and embedded in neutral gelatine. *Result*: Growth of bacillus coli, originating at two points, one-and-a-half inches apart.

(4) Bougie treated in the same way, steamed for five minutes, and embedded in neutral gelatine. *Result*: No growth occurred.

(5) Bougie treated in the same way, steamed for ten minutes, and embedded in neutral gelatine. *Result*: No growth occurred.

(6) Bougie treated in the same way, steamed for fifteen minutes, and embedded in neutral gelatine. *Result*: No growth occurred.

A second series of tests was made. In this instance the bougies were roughened by friction with sand-paper, and the material used for soiling them was the pus from a large acute carbuncle of the neck, which contained staphylococci only. The results were as follows:

(1) Bougie steamed for one minute, and embedded in slightly alkaline gelatine. *Result*: Active growth of staphylococci.

(2) Bougie steamed for five minutes, and embedded in neutral gelatine. *Result*: Growth of staphylococci.

(3) Bougie steamed for five minutes, and embedded in neutral gelatine. *Result*: No growth occurred.

(4) Bougie steamed for five minutes, and embedded in slightly alkaline gelatine. *Result*: No growth occurred.

(5) Bougie steamed for ten minutes, and embedded in slightly alkaline gelatine. *Result*: No growth occurred.

(6) Bougie steamed for fifteen minutes, and embedded in neutral gelatine. *Result*: No growth occurred.

From such results as these, while it is difficult to speak dogmatically, it would appear that an exposure of ten to fifteen minutes should be sufficient in most cases. It may be well to add, however, that in the case of a catheter with rough, uncoated interior, which catheter has been tied into a bladder containing septic urine for twenty-four hours, and which has, in consequence, been permeated by septic material through, possibly, half its thickness, such steaming will probably not be efficient in sterilizing it.

With reference to the second conclusion arrived at, viz. that under only exceptional conditions can the process effect the sterilization of the exterior of a catheter, the facts observed were:

(1) In a number of instances with steam passing briskly through the catheter, and the thermometer in the eye registering boiling point, it is possible to hold, for an indefinite time, the catheter in the hand.

(2) In the case of five different varieties of catheter I performed the following test: Against the catheter was placed the bulb of a delicate surface thermometer. The catheter and thermometer were then tightly rolled in many folds of lint, with layers of waterproof intervening, the ends being left open. The catheter was then attached to the kettle and steamed. *Results*: The highest temperature attained, even under these conditions was 209 F. (with a black French coudé).

With reference to the third conclusion arrived at, it may suffice to say that in this process, as in others, the resisting powers of catheters vary greatly. The majority are temporarily softened and rendered more or less dull on the exterior by an exposure of fifteen minutes. Some do not recover, or but partially recover, their stiffness and lustre. With an exposure of twenty to forty minutes many become blistered and distorted, and after one or two repetitions of the process a

number are rendered entirely useless. It is a somewhat striking fact that those varieties which most require sterilizing by steaming stand it best, while those which have least need of it are most easily damaged by it. Those well-made catheters, for instance, in which the interior is coated as well as the exterior, are apt to suffer from even a brief steaming, the internal coating cracking and curling up, while catheters of inferior make with rough uncoated interiors suffer no material damage till the process has continued sufficiently long to affect the external coat. Certain catheters appear to be quite unaffected by steaming. I have in my possession a red varnished catheter and a black gum-elastic one, both of which have been steamed for not less than fifteen minutes on upwards of thirty occasions, and which appear in no way the worse. These, however, are exceptions.

VI. *Washing with soap and water.* The following series of six catheters was treated in the following way:—After use each was washed with warm water and soap, rinsed in fresh warm water, and held under the tap for five minutes by the clock while a full stream of water flowed through. It was then dried with a towel fresh from the laundry, and thoroughly shaken while completely enveloped in the towel, and subsequently placed to dry for twenty-four hours under glass, with precautions against any possible contamination. It was then split lengthwise with a sterilized knife, and the two halves were embedded in neutral gelatine. The results obtained were:

(1) Black, No. 10, coudé, which had been tied in for twenty-four hours in a case of old prostatic cystitis. *Result:* *Bacillus coli*.

(2) Red varnish, No. 8, catheter, which had been used daily for three months by an old prostatic with putrid urine. *Result:* Cocci arranged as staphylococci and as diplococci.

(3) Catheter coudé, No. 12, passed in case of recent gonorrhoea in patient with old prostatic retention. *Result:* No growth.

(4) Yellow, olivary, No. 10, catheter, tied in for twenty-four hours in case of old stricture and cystitis. *Result:* *Bacillus coli*.

(5) Black coudé, No. 9, which had been used daily for a week in a case of chronic prostatic retention. *Result*: A small coccus, which was not definitely identified.

(6) Black coudé, No. 6, passed in a case of old prostatic retention with recent haemorrhage. *Result*: Diplococci.

These experiments were amongst the earliest I carried out, and at that time I had not become fully impressed with the difficulties in the way of arriving at reliable conclusions by such tests as the foregoing. A number of tests which I subsequently made gave such varying results that it would serve no useful purpose to reproduce them all in full here. What follows therefore has reference to three methods only of cleansing soft catheters.

VII. *Douching with carbonate of soda solution.* The following series of catheters was, after use, treated thus: Each was washed with warm water and soap, thoroughly rinsed in fresh warm water, repeatedly douched through by means of a sterilized six-ounce syringe with 5 per cent. solution of carbonate of soda used as hot as the hands could bear it, and finally again rinsed in warm water and put to dry for twenty-four hours or longer under glass, with precautions against any possible contamination. Each was then split aseptically, and the halves embedded in neutral gelatine. The results were as follows:

(1) Black, No. 8, olivary catheter, which had been several times passed in a case of cystitis due to gonorrhoea. *Result*: *Bacillus coli*.

(2) Black, No. 12, coudé, which had been employed for a month twice weekly by a patient suffering from prostatic retention. *Result*: No growth occurred.

(3) Yellow conical, No. 6, catheter, tied in for twelve hours in a case of cystitis from stricture. *Result*: A growth of a diplococcus.

(4) Red varnished, No. 10, catheter, taken from the collection of a medical man who had repeatedly used it in cases of retention from various causes. *Result*: A growth resembling *bacillus coli*, but subsequently found to be *proteus vulgaris*.

(5) Yellow, No. 10, coudé, employed as a vesical drain in a case of vesico-vaginal fistula and cystitis for twenty-four hours. *Result*: No growth.



(6) Black, No. 8, coudé, employed daily for over two weeks by a patient with prostatic retention. *Result*: A growth of bacillus coli.

VIII. *Douching with warm soda solution and with carbolic solution.* The following series of six catheters was, after use, treated thus: Each was washed with warm water and soap, rinsed in fresh warm water, repeatedly douched in the manner above described with hot 5 per cent. soda solution, and finally repeatedly douched with 5 per cent. carbolic solution. Each catheter was then enveloped in a towel fresh from the laundry and well shaken, and put to dry under glass for twenty-four hours. It was then split aseptically, and each half was embedded in neutral gelatine. The results obtained were:

(1) Black conical, No. 12, catheter, saturated with pus from a case of acute cellulitis. *Result*: No growth occurred.

(2) Yellow, No. 9, coudé, used daily for over a fortnight in a case of prostatic retention with putrid urine. (*N.B.*—This catheter was kept in boracic solution when not in use.) *Result*: No growth occurred.

(3) Harrison's black elastic-gum "whip" catheter, No. 10, F., which had been passed in a case of old stricture with purulent cystitis. *Result*: No growth occurred.

(4) Black coudé, No. 8, tied in for twenty-four hours in a case of acute retention in a patient with old prostatic obstruction and cystitis. *Result*: Growth of diplococci.

(5) Red varnished, No. 10, catheter, tied in for about eight hours in a case of old prostatic retention and cystitis. *Result*: No growth.

(6) Black olivary, No. 10, catheter, which had been used daily for five days in a case of prostatic retention and cystitis. (*N.B.*—This catheter had been simply washed in warm water, held under the tap, and then wrapped in a clean towel when not in use.) *Result*: No growth occurred.

Several of these catheters were distinctly damaged by the treatment. No. 2, which was coated internally, was cracked and roughened both internally and externally. No. 3 was rendered more or less dull and rough, and No. 6 became permanently soft and more or less dull and rough.

IX. *Douching with soda solution and with perchloride solu-*

tion. The following series of six catheters was treated in every way as was the preceding series, except that for the carbolic solution there was substituted perchloride of mercury solution, 1 to 1000. The results obtained were :

(1) Red varnished, No. 10 catheter, taken from a bladder the seat of cystitis of unknown origin, into which it had been tied for five days. *Result*: A vigorous growth which proved to be a mixture of diplococci and staphylococci. (*N.B.*—On splitting this catheter several small phosphatic concretions were found adherent to its internal surface.)

(2) Black, No. 8, conical catheter, which had been passed four times in two days in a case of acute gonorrhoeal cystitis. *Result*: No growth. (*N.B.*—This catheter had been kept in perchloride solution, 1 to 10,000, when not in use.)

(3) Black coudé, No. 12, used in case of acute retention in old prostatic obstruction and cystitis. *Result*: No growth.

(4) Black coudé, No. 12, which was soaked for twelve hours in the fresh pus from a large foetid abdominal abscess, probably perityphlitic. *Result*: *Bacillus coli*.

(5) Yellow, No. 10 coudé, employed daily for a week by a patient with old prostatic obstruction and cystitis. *Result*: No growth. (*N.B.*—This catheter was simply washed with soap and water, held under the tap, and wrapt in a clean towel when not in use.)

(6) Yellow, No. 8 coudé, which was new and had been douched with water which had been boiled. During an hour it was used in four different cases of partial retention, all of which presented more or less cystitis, and in all of which regular catheterism was a necessity. After each of the first three cases the catheter was washed with soap and water and held under the tap, and finally dried by shaking while fully enveloped in a fresh towel. *Result*: No growth.

Catheters Nos. 2 and 6 of this series were rendered dull and more or less rough on the surface, and No. 2 was also much softened.

In all the foregoing tests applied to catheters the water employed for washing and making solutions was, unless otherwise specified, the gravitation water of Glasgow without the adoption of any means of sterilization. The oil used for lubri-

cating the instruments before use was unmedicated olive oil sterilized by heat, and employed very sparingly. In several of the culture tests penicillium developed. As, however, this is known to be due to aerial or other accidental and secondary contamination of the media detailed notes of its occurrence have been omitted. In making the culture tests less than half the length of each instrument was employed, in order to avoid the use of excessively long tubes and very large quantities of media. The half tested was in all instances that including the eye.

*Conclusions regarding the sterilizing of catheters.* In the matter of the sterilizing of bougies the results of the various experiments are clear, and the conclusions arrived at would appear therefore so far definite, and have been formulated above with little, if any, hesitation.

With reference to the sterilizing of catheters this is not so. It is obvious that in the results of the experiments detailed above there are anomalies and a lack of uniformity which render any attempt to formulate general conclusions of comparatively little value. Of the different possible causes of this lack of uniformity several are clear. These are mainly three: (a) The kind of catheter tested; (b) the previous treatment of the catheter tested; (c) the medium inoculated.

(a) The kind of catheter tested. The various soft catheters in the market present the widest differences in quality and finish, and particularly in the finish of the interior and of the eye. I have split several specimens of the catheters supplied me by each of upwards of twenty different firms. For various reasons it is undesirable that I should here give specific details of this examination. So much may, however, be said. There are firms whose catheters are what they are guaranteed to be, viz. as well coated and as smooth internally as externally. Such firms, however, are in the minority, and are not confined to any one country. Certain of these firms supply these specially well made catheters alone, others supply them only when specifically asked to do so, while many firms do not supply them at all, whatever their assertions may be. As already mentioned, it would appear that it is in many instances, though not invariably, the case that the more rough and unfinished

the catheter the better does it withstand damage from vigorous methods of sterilization. For instance, the old red varnished curved catheter is, as a rule, the most rough and unfinished soft catheter obtainable. At the same time it will stand repeated steaming internally, somewhat prolonged immersion in strong carbolic or perchloride solution, and even fairly prolonged boiling. On the other hand, highly-finished catheters, the interior of which is as accurately coated and as smooth as the exterior, tend to suffer speedily from internal steaming, immersion in antiseptic solutions, and even vigorous syringing with soda or antiseptics, if at all concentrated.

With reference to the bearing of the finish of the interior on the matter of sterilization by various methods as tested by culture experiments, it is obvious that it may introduce serious error into any attempted generalization. If, for example, in the treatment of a case of purulent cystitis there be used two catheters, the one accurately coated, smooth, and glossy internally, and the other quite unfinished internally, it is evident that the first may be possibly rendered aseptic by washing with warm water and soap and douching with some antiseptic, but that such treatment may prove quite inefficient in respect of the second in which the purulent urine in its passage has soaked into the uncovered silk or linen web forming the skeleton of the instrument.

(b) The previous treatment of the catheter tested. A certain number of the tests quoted were carried out with catheters which had been in use in septic cystitic cases for days or weeks. It is obvious that the results obtained by a given method of sterilization carried out in the case of a catheter passed nightly by a prostatic cystitic patient, who carefully washes his catheter and lays it aside in a weak antiseptic solution in the intervals, can form no criterion by which to judge of the effect of the same method of sterilization as applied to the same catheter employed nightly by a patient in a similar condition, who merely wipes his catheter after use and carries it in his pocket or stores it in the commode till he next requires its help. To further quote illustrations appears unnecessary.

(c) The medium inoculated. How far exactly this may



introduce sources of fallacy is difficult to say. That it may be capable of vitiating the results of a whole series of tests I know from experience. Comparatively slight alterations in reaction of a medium and alterations in its constitution would appear to be capable of preventing or promoting the growth of certain organisms, and thus leading to erroneous conclusions. The subject is one of enormous difficulty, and I would desire to speak with much reserve in the meantime. As indicated below, Drs. A. R. Ferguson and Leslie Buchanan are kindly investigating the matter with me at the present time.

Those three sources of fallacy, with others of minor importance, have been so obvious in the experiments above detailed, as well as in others I have conducted, that anything further in the way of comparison than the comments and conclusions I have indicated under each method of sterilization tested would appear unwise.

The *metal* catheter and the *soft red rubber composition*, or *Jacques'* catheter, may be readily and certainly rendered sterile for an indefinite number of times either by boiling or by washing and immersion in sufficiently powerful antiseptic solutions, and this without sustaining damage.

With regard to the sterilization of all forms of "*gum-elastic*" or "*varnished*" catheter it is perhaps not too much to say that, while there are various methods which are not, when repeated, destructive of the catheter, and which in the way of asepsis of the catheter offer a "reasonable degree of security," there is no method which is entirely reliable. Further, as my experiments seem to indicate, it may also be said that there are reputed methods of sterilizing catheters which, when accurately tested, fail to justify the faith placed in them.

For practice I have formulated for myself certain rules:

(1) Avoid, as far as possible, the employment of catheters. In cases of stricture, for instance, it can only be very exceptionally indeed that the use of a catheter is called for. Bougies, metal or soft, which are readily and certainly sterilized, will do all that is necessary.

(2) When a catheter must be employed use, where possible, a red rubber Jacques' catheter in preference to a gum-elastic or metal one. In such cases as retention due to atony, spinal

paralysis, reflex nervous effects, and other causes, and in many cases of prostatic retention, a red rubber catheter answers quite as well as a gum-elastic or varnished instrument, and is as readily sterilized by boiling or immersion in antiseptic solution as is a metal one.

(3) In cases where the use of a catheter is necessary, but in which a red rubber instrument fails to pass and something stiffer must be employed (as, for instance, in many cases of prostatic retention), the use of metal catheters, especially by the patient, does not commend itself as a measure free from grave risk of injury to the prostate or urethra. One has therefore to fall back on gum-elastic catheters.

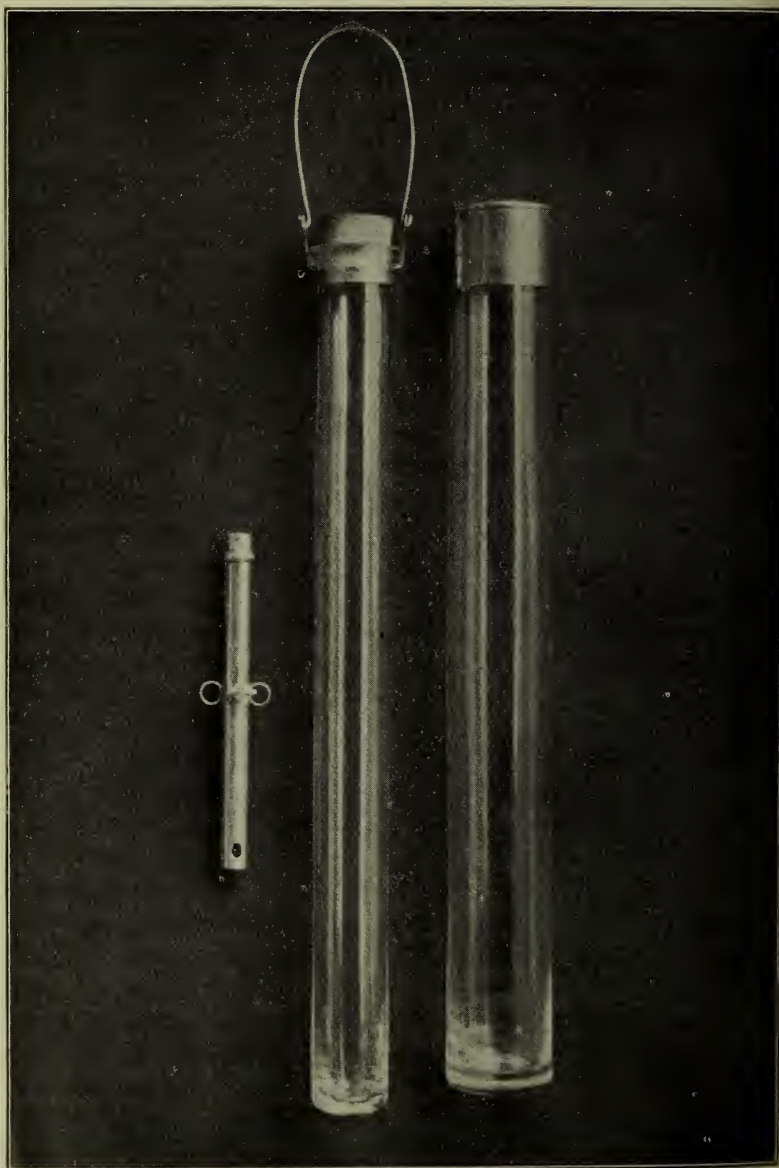
In such cases, if the urine be very septic, I destroy any catheters I have employed. If the urine be not very purulent or offensive I subject the catheters used to external washing with soap and water, and then with antiseptic solutions, followed by internal steaming. Those which survive I retain.

For those cases where the regular use of a gum-elastic catheter is necessary the patient is supplied with a catheter with well-finished interior. After use he thoroughly washes it, holds it under the tap for a few minutes, and then lays it aside in a dish of boracic, weak perchloride, or other weak antiseptic solution. I do not believe that this primitive treatment offers more than a "reasonable chance" of asepsis, but I know, from experience, that it is useless to expect an average patient to carry out anything more elaborate in the way of cleaning.

Moreover, when a prostatic patient has reached the stage of regular catheterism, with all its risks of septic cystitis and vesical atony with their grave sequelae, it comes to be a question for his medical adviser whether his condition warrants an operation for the radical cure of his trouble by means of prostatectomy or castration.

Some years ago I had constructed the glass tubes or bottles figured in the illustration. They are made with either metal or rubber stoppers. In these I store and carry catheters for use. Any catheter used is simply washed and held under the tap and laid aside (or carried home wrapped in a towel or gauze) for sterilization before it is replaced in the glass receptacle.

For prostatic patients who either decline operation or are not fit subjects for it, and who therefore must use a catheter



regularly, I have had these glass receptacles fitted with a metal handle (see illustration). By means of this they may be hung on the bed or in the wardrobe. Filled with an antiseptic fluid they are at hand for the catheter after use, and when emptied of fluid may be used for storing the catheter while travelling. The antiseptic fluid will vary in strength according to the kind of catheter employed, it being necessary to employ weak solutions for gum-elastic catheters, while red rubber catheters will stand anything.

The illustration also shows a metal perineal drainage tube. Surrounding it is a metal ring or collar tightened by a screw or clip. The tube is inserted into a bladder, the tapes fastened to the "eyes" on the collar, and the collar so adjusted by means of the screw that the internal aperture of the tube rests in the *base* of the bladder. I believe the tube has two advantages over the ordinary red varnished perineal tube: (*a*) It may be sterilized in five minutes and replaced fresh; (*b*) by adjustment of the collar the inner end of the tube may be kept at the level of the floor of the bladder, thus acting as a drain of the whole viscus. The old red tube is fixed by a piece of wire in more or less hap-hazard fashion, and frequently in such a way that the internal aperture projects far into the cavity of the bladder, leaving the urine (flowing from the ureters at a lower level) either to accumulate in the lower part of the bladder or find exit alongside the tube.

## PART II.

The second part of the investigation, viz. that into the presence or absence of bacteria in the urethrae, morbid and normal, into which in practice instruments have to be passed, I was led to undertake by the discussion which followed a paper which I read before the Glasgow Medico-Chirurgical Society in November, 1893, and which was subsequently published in the *Glasgow Medical Journal*. In that paper and in the discussion which followed, in arguing for the employment of soft bougies (and catheters) in preference to metal ones in cases of urinary retention, more particularly in cases of tight or



tortuous stricture, I expressed the conviction that soft *bougies* could be as readily rendered sterile as could metal ones, that the same might be claimed for *red rubber catheters*, while *gum-elastic catheters*, though not so readily or certainly sterilized, might, when of good quality, by a combination of washing and internal steaming, be rendered sterile for a certain number of times after use. These statements, based on previous practical experience, are, I venture to believe, fully borne out by the more formal experiments I have since then conducted, and which are published in the first portion of the present paper.

In the paper of 1893 I adduced evidence of the change of opinion in favour of soft as against hard instruments, which, originating in France, and led by Sir Henry Thomson in this country, and by American surgeons, has within the last twenty years largely revolutionized practice in cases of stricture and of urinary retention generally; and I pointed out that in Scotland, while soft instruments are now used for prostatic retention and for retention from vesical paralysis and atony, there is a decided tendency to retain the use of metal instruments in cases of stricture. The reason for this somewhat illogical use of metal instruments in stricture, while soft instruments are employed for prostatic and spinal retention cases, appears to lie mainly, if not solely, in the belief that soft instruments are less readily sterilized than are metal ones. That, as regards *bougies* (the instruments then under discussion) at least, this is certainly not the case the foregoing experiments would seem to indicate, and my opinion to this effect I stated at the meeting and in the paper referred to. I further drew attention to the point that even, for the sake of argument, granting this view to be correct, it represents one side only of the question. In a case of tight stricture the condition of the channel through which the instrument has to be passed is of as much importance as the condition of the instrument, in certain cases probably of more importance; while in all cases demanding instrumental treatment the nature of the fluid in the bladder and the character of any moisture or discharge present in the urethra may constitute features in the case of graver import than the condition as regards asepsis of the instrument employed.

In the paper and discussion referred to, two points were drawn attention to, (*a*) the condition of the gastro-intestinal tract from mouth to anus. This is constantly occupied by the most septic contents without detriment to the health of the patient. The most trivial wound of any part of the mucous membrane, however, is apt to result in the production of septic mischief, frequently of the most rapidly fatal kind. (*b*) The fact that the larger number of strictures are not mere annular constrictions, but long tortuous narrow channels, often with eccentric openings and with sharp angles and curves, of the direction and position of which the surgeon is ignorant. Along such a channel it is manifestly never easy, and is frequently impossible, for the surgeon to pass a rigid metal instrument of a calibre of the necessary smallness without abrading the surface of a curve or ploughing up an angle, even though he may successfully ultimately enter the bladder without the formation of an actual false passage. Through such a channel, on the other hand, fine or small-sized soft instruments, held lightly between finger and thumb, may be wriggled without damage, the pliable point and neck adapting themselves mechanically to the curves and angles of the channel, anything like abrasion or tearing being impossible.

Succeeding the foregoing, the following passage occurs in the paper: "Let it, for the sake of argument, be assumed for the moment that this statement" (*viz.*, that soft instruments are less readily or certainly rendered pure than are metal ones) "is absolutely true in fact; it will not be difficult to prove that the argument based on it, even if its truth be assumed, is specious. . . . Given a case of tight, tortuous, or oblique stricture, with swollen congested surface covered with mucopurulent gleet discharge, and with possibly cystitis and purulent urine in addition. Take to treat it a soft instrument, filthy and septic. In the majority of cases you can gently wriggle this through, and that without abrading any part of the mucous membrane, thus dilating the stricture and giving free exit with the urine over the intact mucous membrane, not only to anything septic you may have introduced, but to the discharge in the urethra and the pus in the urine. Take, on the other hand, a small No. 1, 2, or 3 steel bougie or catheter,

carefully sterilized, and, in passing that through, make but the slightest abrasion, and you establish a condition of affairs in which it is not your fault if septic mischief does not ensue. . . . What I have for the moment admitted for the sake of argument, however, I do not in any sense admit as an actual fact, namely, that soft instruments, when intelligently managed, tend more to be septic than metal ones."

How far these statements of opinion, based at the time when they were made on general observations, are borne out by specific investigation may be gathered as regards the instruments from the records of the experiments detailed in the first portion of the present paper. How far they may be accepted as regards the urethra may be to a great extent gathered from what follows, though, as previously mentioned, the investigation is not yet completed.

*Series* of twenty-four cases of stricture examined in the dispensary and wards of the Western Infirmary, in the Glasgow Central (formerly Andersonian) Dispensary, and in private practice. Reproduction of detailed notes of these cases would serve no useful purpose. They were cases of ordinary urethral stricture coming for treatment either on account of acute retention or in the course of treatment by gradual dilatation. All had had instruments passed by various people on occasions previous to that on which the examination was made. The media inoculated were gelatine, agar, and glycerine agar. The procedure in all cases was the same. Before passing an instrument the meatus was cleansed with carbolic lotion (1-40), and dried with sterilized gauze. A pair of fine sinus forceps, sterilized in the flame of a spirit lamp, was then passed into the urethra to the extent of about an inch, and opened. Between the blades, and therefore out of contact with the urethral orifice, a stout platinum wire with a looped end, carefully sterilized in the flame, was passed into the urethra. The distance to which this was passed varied from two to eight inches in different cases. In withdrawing it care was taken to keep it between the blades of the forceps, and therefore free from contact with the meatus, and inoculation of the medium was at once made.

The results were as follows:

Case 1. *Bacillus coli*.

Case 2. *Bacillus coli*.

Case 3. No growth. The patient was not seen again.

Case 4. *Diplococcus* and *bacillus coli*.

Case 5. No growth. Three weeks later a second inoculation test yielded a growth of *diplococcus*.

Case 6. *Diplococcus*.

Case 7. *Diplococcus* and a *staphylococcus*.

Case 8. *Bacillus coli*.

Case 9. *Bacillus pyogenes foetidus* and *staphylococcus aureus*.

Case 10. No growth. Patient not seen again.

Case 11. *Bacillus coli*.

Case 12. *Diplococcus* and *staphylococcus aureus*.

Case 13. No growth. Eight days later a second inoculation test yielded also a negative result.

Case 14. *Diplococcus* and *bacillus coli*.

Case 15. Large white coccus growing freely. Several secondary cultures were grown, and the growths submitted to three bacteriologists, but no definite decision was arrived at.

Case 16. *Diplococcus* and a *staphylococcus*.

Case 17. Growth of cocci. Culture accidentally destroyed before the germ had been identified.

Case 18. *Bacillus coli*.

Case 19. *Bacillus*, investigated by secondary cultures, and variously pronounced to be *bacillus pyocyaneus*, *bacillus subtilis*, and *proteus vulgaris*.

Case 20. No growth. A second inoculation test a week later yielded a *staphylococcus*.

Case 21. Large white coccus not definitely identified.

Case 22. *Diplococcus* and *streptococcus pyogenes*.

Case 23. *Diplococcus* and *bacillus coli*.

Case 24. Coccus arranged as a *streptococcus*.

In the foregoing series of tests the media were prepared in different places and by different people. No accurate record of the reaction was kept. The composition and reaction of the media may have, as further research has taught me, a very decided effect on the results of inoculation tests. I have in my possession records of inoculation tests recently made which



clearly demonstrate this. Two instances may be given: (1) T. H., aet. 2 years, operated on at the Children's Hospital for tubercular disease of the metacarpus. While under chloroform the urinary meatus was cleansed and inoculations made from the urethra on acid agar and on alkaline agar. The alkaline tube yielded a luxuriant growth of a large diplococcus, while the acid tube remained sterile. Secondary inoculations were made from the growth in the alkaline tube into (*a*) the original acid tube, (*b*) a fresh acid tube, (*c*) a fresh alkaline tube. Tube *c* yielded a vigorous growth of the same diplococcus, while *a* and *b* remained sterile. (2) M. A., aet. 37, operated on for varicocele. While under chloroform the meatus was cleansed and inoculations made in neutral glycerine agar, which yielded a mixed growth of a diplococcus and a large coccus. Attempts to produce secondary cultures on neutral glycerine agar failed, but both germs grew well on alkaline agar.

These are not the only difficulties of the investigation. The whole subject bristles with them. For instance, in investigating a series of normal urethrae, I have several times failed to obtain cultures by the method above described, viz. that of passing a loop of platinum wire into the urethra, and subsequently succeeded by gently scraping the urethral mucous membrane with a fine curette, and making inoculations with that. Again, I have on several occasions obtained films on coverglasses, in which germs were readily demonstrated by staining, by scraping urethrae which were normal, or by scooping out discharge from urethrae, the seat of gonorrhoea or gleet, in cases in which careful inoculation yielded no result.

Nor does this end the list of difficulties. There is one of probably greater magnitude than any of the foregoing. In the series of tests above detailed, the term "diplococcus" is largely employed, and I have been driven to the use of this collective term by two considerations. In the first place, and here I would speak at present with very definite reservations, I am not certain that there is any way of distinguishing between the "gonococcus" and the other diplococci. There may or may not be. At present I do not know. Of one thing, however, I am convinced, and believe I already have the means of demon-

strating, viz. that much of what is published in the various text-books on this matter must be received with caution, if not ultimately entirely discarded as erroneous. In the second place, and to a large extent proving the preceding statement, I have repeatedly received contradictory reports from different competent bacteriologists on the same germ. In my possession are a large number of detailed reports on such cases. Repeatedly the same germ has been termed "gonococcus" by one authority, "micrococcus urea" by another, and some one or other of the various diplococci by a third. And in reading the reasons detailed in these reports for the decisions come to, one ceases to wonder at the differences of opinion contained in them, and, as already stated, giving such contradictoriness to the various published statements. The personal equation, for one thing, must be reckoned with. Particularly in the matter of Gram's test is this so. What means decolourization to one eye is not so in the view of another of equal experience. Further, in making a series of examinations, as cases occur, germs which did not decolourize by Gram's method at the time of staining may gradually lose colour on being kept till, in the course of weeks or months, the series is completed, the result being that the same germ may be at one time pronounced "micrococcus ureae," and at another, "gonococcus" by different observers, or even by the same observer.

Again, there is the frequently quoted statement that the relative size of the germs grown forms a distinctive point as between the gonococcus and the other diplococci of the urethra. My experience over a large series of cultures has been such as to raise, though not by any means to settle, the question whether it may not be the case that a given diplococcus varies in its size at different periods of its growth in the same culture, and whether it may not be distinctly modified in size in successive secondary cultures. This question opens the entire field of mixed cultures (whether in artificial media or urethra), and of the effect of alterations in composition and reaction of media, and is manifestly one not capable of ready solution.

One other point remains. The appearances of a number of cultures (and I have before me now a series of growths, highly suggestive in this connection) raise the further question of the

relation of various morphological forms of germ found in the same culture. Take a tube in which, within a few days of inoculation, there are found patches of growth, which, on microscopic examination, are noted as "Staphylococci of a size distinctly larger than those obtained from a recent case of facial boil. Staphylococci of very much smaller size. Diplococci of large size. Diplococci of smaller size and less defined outline." (This is the note of an actual culture obtained from a perfectly normal urethra). There are two possible explanations. (a) The tube contains a mixed growth; (b) the tube contains a culture of one germ only, which is in process of actively reproducing itself by fission. The solution of this question may or may not be possible in a given case. In any event, it demands weeks of work in the production and observation of secondary cultures in media of various compositions and reactions.

During the past four years I have carried out carefully made and noted bacteriological tests in the following, amongst other, series of cases:

Cases of prostatic retention requiring instrumental aid.

Cases of tubercular disease of the prostate.

Cases of acute gonorrhoea.

Cases of chronic gleet.

Cases of adults with normal urethrae.

Cases of children with normal urethrae. (This investigation, carried out in cases under operation in the Children's Hospital during 1896, yielded some puzzling and suggestive results.)

The records (with, in many cases, the actual stained specimens, and, in a number, with microphotographs of the germs) of all the results are in my possession, and it had been my intention to publish them as part of this paper.

In the face of the difficulties and sources of fallacy above indicated, and of the secondary or subsidiary lines of investigation which have opened out in the attempt to eliminate these sources of fallacy, it seems preferable to delay publication in the meantime.

As already stated, Dr. A. R. Ferguson, Assistant Pathologist, Western Infirmary, and Dr. Leslie Buchanan, Pathologist, Eye Infirmary, have kindly consented to aid me in further investi-

gation, and have, indeed, already done much work in the matter, the records of which it is intended to embody in a joint paper. That the result of the investigation going on will be to finally settle all doubtful points in the subject no one practically acquainted with the nature of the difficulties will venture to predict. On the other hand, looking to the special fitness for such work of my collaborators, by reason of their special knowledge and great facilities, and having regard to the great amount of time and skill being devoted to the production of the records and specimens accumulating in Dr. Ferguson's hands, and of the microphotographs of these specimens accumulating in Dr. Leslie Buchanan's hands, it is possible that the publication of these records and microphotographs, with particulars of the cases to which they relate, may provide material to form a basis on which certain conclusions may be founded, and from which the investigation of possible difficulties may take origin.



## ON THE MANAGEMENT OF RUPTURED URETHRA, WITH REPORTS OF THREE CASES, INCLUDING ONE OF SECONDARY RESECTION.

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EXCLUDING cases of injury to the pendulous portion, ruptures of the urethra fall into two groups, according as they result—

- (a) From violence applied to the perinaeum ;
- (b) From laceration, in fracture of the pelvis.

Iversen<sup>1</sup> divided ruptures of the urethra into (a) those in front of the triangular ligament, and (b) those of the membranous portion, and attached great importance to this division both for diagnosis and prognosis, the point of importance being in his view the integrity or otherwise of the compressor urethrae between the layers of the triangular ligament, with, in the former case, preservation of the control over escape of urine from the bladder, and, in the latter, loss of this control and early urinary extravasation.

To what extent this distinction is borne out by the cases cited it is impossible to judge from the *resumé* in French which accompanies the original paper, but certain considerations may be adduced which seem to preclude its absolute acceptance. In the first place, it is to be pointed out that in many cases the first indication to the patient that there is anything seriously wrong is the discovery that he cannot pass urine at all, and further, that though he strains, repeatedly it may be, he gets rid of nothing but a few drops of blood

<sup>1</sup>*Nordiskt Medicinskt Arkiv.*, Bd. xix. 1887.

from the meatus, and *has no extravasation of urine into the tissues*. This is the typical condition of things in ruptures caused by injuries to the perinaeum, where presumably the bulbous portion is principally involved; but setting aside in the meantime the question of the exact localization of the lesion in such cases, there is, I think, reason to believe that the same symptoms may occur when the membranous portion is undoubtedly and seriously injured. By the kindness of Dr. Hector C. Cameron I am enabled to refer to a case in illustration of this. The case came, at a late stage, under my own observation as House Surgeon, and the pelvic skeleton is now in the Museum of the Western Infirmary. The following account of it is given in the Museum Catalogue:—"Series I., 36. Healed fracture of the Pelvis of eight years' duration. The specimen shows a complete union, but with some displacement, of a fracture of the pelvis. In front there is considerable thickening about the external extremity of the right os pubis, the horizontal ramus being considerably shortened and thickened. There is again a fracture on this side at the lower part of the ascending ramus of the ischium. On the left side there is also thickening at the external part of the horizontal ramus of the pubis, and a fracture of the ascending ramus of the ischium, the latter, with great over-riding of the two fragments, resulting in a marked asymmetry of the pelvis, the right side being much deeper from pubis to tuberosity of ischium than the left. Behind there is a united fracture on the left side . . . the fracture seems to have passed through the sacro-iliac synchondrosis and thence across the wing of the ilium. It is somewhat irregularly united, and the sacro-iliac synchondrosis is ankylosed along with it. On the right side there is no appearance of fracture posteriorly.

"James C., aet. 38. The patient was admitted to the Royal Infirmary, under the care of Dr. Cameron, eight years before death, for fractured pelvis and ruptured urethra. The two halves of the pelvis were freely movable on each other, and the membranous urethra torn across.

"It was necessary to puncture the bladder above the pubis, and it was drained by this aperture for three weeks.

Perinaeal section was then performed, and he was ultimately dismissed well. Five years afterwards he was admitted to the Western Infirmary with stricture, when Wheelhouse's operation was performed. He was re-admitted after three years with similar symptoms. A perinaeal operation was again performed, and was followed by suppression of urine for two days. He then improved for some days, but then became collapsed, and died. Inflammation of the bladder and pyonephrosis were found." (Path. Reports, No. 1892, June 15th, 1888.)

It may, I think, be assumed that we have here a typical illustration of the injury that is produced when the pelvis is fractured by lateral compression (patient was engaged in coupling waggons and was caught between buffers), and the fact of importance for my purpose in connection with it is that at no time during the three weeks prior to the perinaeal operation did he have any urinary extravasation. This I have on Dr. Cameron's authority, and he further states that far from suprapubic puncture having been promptly done, the patient lay for a good many hours in the ward before his condition seemed to justify any interference whatever, while for some days afterwards aspiration was done intermittently morning and evening before a drain was left in permanently. When the perinaeum was incised, a catheter was only introduced into the bladder by means of a bougie passed from the suprapubic fistula as a guide.

Secondly, in view of the rarity of early urinary extravasation after falls stride-legs, the question of the exact localization of the injury to the urethra becomes of interest. Iversen spoke of it as occurring usually in the region of the bulb from one to three centimetres in front of the triangular ligament, but it may be expected that this will vary somewhat in relation to the direction and degree of the violence. Mr. Morris (Treves' *System of Surgery*, vol. ii., p. 868) says, "When the rupture is caused by falls astride it is situated at the bulbous portion of the urethra. Contusions of the perinaeum, caused by blows from before backwards, will likewise rupture the urethra at this point, whereas direct blows on the posterior part of the perinaeum, directed from behind, damage the membranous portion

of the urethra immediately behind the bulb. In every case it is the pubis which acts as the 'point d'appui' for the rupture. In fractures of the pelvic bones, it is the membranous urethra which is most commonly ruptured."

Mr. Fenwick (*Cardinal Symptoms of Urinary Disease*, p. 62) says of the same class of cases, "The rupture is usually situated in front of the triangular ligament, or involves the anterior layer of that fascia."

The question of the exact mechanism involved in production of the rupture is also of interest. Mr. Morris' opinion that the pubis is the "point d'appui" in all cases has already been quoted. Guyon and Terrillon (White, *American System of Surgery*) concur in this view, stating that the rupture is frequently partial only, involving, in that case, the lower wall of the urethra, in which latter point they are at one with Iversen. Velpeau also is quoted by White, as stating that the urethra suffers by being nipped against the symphysis or descending ramus of the pubis. Ollier, on the other hand, finds the "point d'appui" in the triangular ligament where the urethra passes through it, and against the edges of the aperture in that structure he supposes the urethra to be torn. It is to be noted that in experiments made by him the upper wall appeared to have been torn.

It may be submitted that each of these causes is operative in individual cases, and that while the condition of the parts at operation or post-mortem often makes it difficult to speak with precision of the nature of the damage and its site, what we know of the triangular ligament and its fixity makes it difficult to believe that where the injury is immediately in front of that structure, or between its layers, the urethra, which is fixed by it, can have been carried against the symphysis, except as a part of a very extensive laceration involving the ligament itself. Where the injury is further forward—and it is to be noted that Iversen speaks of a range of three centimetres from the triangular ligament—nipping against the symphysis affords a probable enough explanation, while it is impossible to suppose that violence at such a position would cause any such sharp drag on the urethra at the point of passage through the ligament as to cause the urethra to tear.



The three cases which have come under my care have all been caused by falls stride-legs. None have had extravasation of urine. Whether this depends on integrity of the deep transversus perinaei, I am unable to say, but in view of the considerations which I have adduced, I think that this is not necessarily so. All had retention, and it seems to me not unreasonable to suppose that this may be dependent on spasm of the prostatic urethra, a reflex spasm due to the injury further forward.

It is not for want of an attempt to pass urine that extravasation does not occur, and in the attempt it may be supposed that the deep transversus perinaei is more under control than the involuntary muscle fibres which form the true sphincter vesicae. Further, in the stage at which in these cases extravasation does occur, namely, in the stage of overflow, spasm may be expected to have passed off, and the extravasation must be supposed to occur, not because of obstruction from a voluntary muscle, which may be entirely proximal to the lesion, but from the loss of continuity of the urethra, swelling of the parts, and blocking of the distal end by clot.

All three cases had distended bladders when they came under observation, and all were treated in the first instance by suprapubic drainage. A large trocar and cannula was made to enter the bladder, and through the cannula a worm catheter was passed and fixed to the skin by a strip of gauze and collodion. Only after an interval of some days was direct attention given to the urethral injury, when an incision was made into the perinaeal swelling, and a soft rubber catheter passed through the whole length of the urethra. Only in one case were stitches put into the urethra itself (the boy W. P., who afterwards had resection done), nor was the perinaeal wound completely stitched in any case. Even after clearing out all clots the healing seemed likely to proceed more certainly if some provision were made for the escaping of any oozing from the contused tissues, by keeping the wound packed with iodoform gauze. The suprapubic drain was kept in for some days after the urethral one had been introduced, in order to prevent any risk of blocking of the urethral catheter and irritation of the wound by leakage alongside of it, and that this is a

real danger I was reminded by the temporary block and leakage which took place in the case of W. P. in spite of the presence of both tubes. It is to be noted that this patient developed shortly a very tight stricture. While the resection wound in this case was healing, the same method of drainage from above and below was practised.

The insertion of a suprapubic drain as an immediate and temporary measure, while it obviates the possibility of urinary extravasation, is to be recommended, it seems to me, as giving, in the course of the next two or three days, a route by which a guide can be passed from above into the posterior urethra in case it should, at the operation, be difficult to bring the two segments of the urethra into relation to each other. Meantime, the patient can have his bowels cleared out without risk of fouling the perinaeal wound, and the skin in the perinaeum can be properly purified.

The urethral catheter is fixed to the skin of the penis by a strip of gauze and collodion, care being taken not to encircle that organ. This arrangement is infinitely more comfortable to the patient than any more rigid form of catheter, with or without stylet, and I have never had any trouble from it in having the catheter expelled in these or other cases where I have used it.

In carrying out continuous drainage of the bladder I have been amply satisfied with the arrangement described, the fall of  $2\frac{1}{2}$  to 3 feet being enough, and more than enough, to keep up the syphon action required. Increase of the suction by a flow of fluid from a reservoir which communicates with the tube from the bladder is unnecessary, and may defeat itself by sucking the mucous membrane into the eye of the catheter, and so causing a block. If, with the arrangement described, a block does occur, this will be recognizable by the nurse, who can see that the urine in the receptacle is not increasing. To facilitate this observation it is well to have the tubes end each in a separate tall bottle or glass jar. The block can usually be put right by a backward injection through the catheter that is at fault, and at the same time shifting its position slightly.

Rupture of the urethra, besides its immediate inconvenience and danger in retention and risk of extravasation, has the

more remote gravity which depends on its tendency to be followed by stricture. That being recognized, it may be permitted to point out that no one need vex himself when in ordinary practice he finds himself unable to pass a catheter into the bladder in such a case. Whether he can pass a catheter or not is very little to the point, and much harm may result from ineffectual attempts. Suprapubic puncture will relieve the patient for the time being, will prevent urinary extravasation, and will enable the patient to wait till the seat of injury can be dealt with by a surgeon; for, whether a catheter can be passed or not, the perinaeum will have to be opened up and clots removed if the urethra is to heal without a stricture.

While stricture of gonorrhoeal origin has been successfully treated in some cases by resection, it seems plain that in a large proportion this procedure must be inapplicable. The stricture may be too far forward; it may be multiple; such a length of the urethra may be involved as to preclude the bringing together of the resected ends, or a persistent septic infection of the urethra may compromise any operative procedure of the kind.

With traumatic stricture the case is otherwise, and the gravity of the condition, its intractableness by dilatation or external urethrotomy, have led to the performance of resection by a number of surgeons with results which have established the procedure.

In the *Archives Provinciales de Chirurgie* for July, 1892, there is an article by Vignard on this subject. Fifteen cases are quoted from French, German, and English sources, dating from 1883. Two to three centimetres is not uncommonly mentioned as the amount resected. The most extensive stricture is one of six to seven centimetres in a case of Mr. Mayo Robson's. In this case, No. 13 (English) bougie could be passed without difficulty six months later.

## CASE 1.

*Perinaeal Rupture of Urethra. Suprapubic drainage of Bladder. Healing over catheter after incision and clearing out of perinaeal swelling. Good result observed after three years.*

John M'D., aet. 33; admitted to Ward 23, Glasgow Royal Infirmary, 16th June, 1894, while I was acting for Dr. James A. Adams. On the previous day patient blundered in getting on to a bicycle. The bicycle fell and he with it, striking his perinaeum on the hind wheel. He felt sick for a few minutes, then mounted again, but had to get off on account of pain, walking home about a quarter of a mile. When he got home he found he could not sit down on account of the discomfort. He was seen by a medical practitioner about midnight. Fomentations were applied, but no attempt was made to pass instruments though he felt that he could not make water. Next morning the pain due to retention was worse, and the swelling in the perinaeum had increased. At mid-day an attempt was made to pass soft instruments without success, some blood coming away.

On admission that afternoon patient was able to walk to bed, but was in great pain and could not pass water. There was found ecchymosis and swelling from the middle of the perinaeum forwards over the scrotum, and along the upper and under surfaces of the penis. The swelling behind the scrotum was tense, hard, and tender. There was also discoloration over the inside of both thighs. Neither soft nor metal catheters could be passed into the bladder. No force was used. On withdrawing the instruments some blood came away, and following this a small quantity of urine came away—not more than half an ounce. The bladder was tapped suprapubically. This was repeated early on the morning of the 17th, and at 2 p.m. the same day, using a large trocar and cannula, a worm catheter was passed into the bladder and fixed with collodion. On the 22nd, patient being put under chloroform, Dr. R. incised the swelling in the perinaeum, which, though flaccid, was covered with a rather brawny skin. A collection of foetid pus was opened into, coming away from in front of the rectum,



and dissecting out the region of the bulb and membranous urethra. Again an attempt was made to pass an instrument from the meatus, but the point became entangled about the position of the triangular ligament. A bougie was then passed down through the suprapubic fistula, made to enter the urethra from the bladder, and projected through a ragged opening in what seemed to be the membranous portion. A worm catheter was then introduced at the external meatus, brought out in the perinaeal wound, and made to follow the bougie as it was withdrawn into the bladder.

A few days later the suprapubic drain was withdrawn, and on the 3rd July (eleven days after its introduction) the urethral catheter was also withdrawn. On the 6th July the perinaeal wound, which had been packed with iodoform gauze, was stitched, and on the 13th patient was sent home.

On the 28th July patient came to report himself, saying that he thought the stream was not so full as it had been. On examination No. 15-18 (Lister) passes quite easily.

He was provided with a flexible bougie and instructed in its use. In October, 1896, and again in November, 1897, he reported himself well and free from any ill effects, as a precautionary measure passing, up to the latter date, his bougie once in ten weeks.

## CASE 2.

*Perinaeal Rupture of Urethra. Suprapubic drainage of Bladder. Healing over catheter after incision and clearing out of perinaeal swelling. Good result observed after three years.*

John P., aet. 33, porter; admitted 22nd Sept., 1894, to Ward 20, Glasgow Royal Infirmary, where I was on duty for Dr. Fleming.

That forenoon while doing some work in his own house, he fell astride the back of a chair; suffered much pain at first, and found himself unable to pass urine; was able to walk about.

On admission ecchymosis was found of the whole scrotum

and perinaeum, extending for two or three inches around the anus; no ecchymosis of penis; skin unbroken.

An attempt was made by the House Surgeon to draw off the urine with soft and metal catheters without success. The instruments seemed to leave the urethra in the perinaeum, and were withdrawn covered with blood.

Dr. Rutherford saw the patient at 6.30 p.m., and after an attempt at catheterization, passed a trocar and cannula into the bladder above the pubis. A worm catheter was passed through the cannula, and the cannula withdrawn. A long rubber tube was attached to the catheter, and the urine allowed to drain off into a slipper by the side of the bed.

*24th September.* Under chloroform Dr. Rutherford cut down on a staff in the perinaeum, turning out large masses of clot from around the urethra in the bulbous and membranous regions. The urethra seemed to have been completely torn across, but where exactly in relation to the triangular ligament could not be determined. Difficulty was encountered in making a bougie enter the urethra from the bladder to serve as a guide, and the perinaeal wound had in consequence to be enlarged. The proximal end of the urethra was then found, and a No. 12 soft rubber ("worm") catheter was passed along the penile portion into the wound, and then from the perinaeum into the bladder. The catheter could be seen in the wound for fully an inch when patient's thighs were bent on his body.

The wound was partly stitched, and packed with iodoform gauze.

*27th September.* Pad on perinaeum changed; it is found dry. Suprapubic drain withdrawn.

*30th September.* Suprapubic wound closed, and dry pad on perinaeal wound changed. Urine all coming by catheter.

*3rd October.* Stuffing all withdrawn from perinaeal wound.

*12th October.* Catheter removed; wound healed, except superficially there has been no escape of urine by it.

*19th October.* Dismissed well.

*27th October.* Complains that urine is not passing so freely as at first. Lister's bougies passed up to No. 12.

*30th October.* Bougies up to No. 15.

13th November. Bougies passed up to No. 20. No obstruction to be felt. Patient passes urine freely.

5th October, 1896. No instrument passed for six months. Patient returned by instructions to report himself. He is quite well, and has no trouble in micturition. A small nodule the size of a pea can be felt in the perinaeum opposite the middle of the scar. The skin moves freely over it. Bougies up to No. 20 passed in without pain or bleeding, and with a scarcely perceptible resistance in the case of the last two.

December, 1897. Examined again. Bougie 17-20 passed at once with only a slight hitch.

### CASE 3.

*Perinaeal Rupture of Urethra. Suprapubic drainage of Bladder. Healing over catheter after incision and clearing out of perinaeal swelling. Rapid formation of stricture. Excision of stricture. Result at end of eighteen months.*

William P., aet. 10; admitted to Ward 25, Glasgow Royal Infirmary, 16th September, 1896, while I was acting for Mr. H. E. Clark.

About 4 p.m. he fell astride of an iron rail on which he was walking. After this he was able to go back to school for an hour, and thereafter walked home in considerable pain. He then found that he could not pass urine, and that there was a swelling in the perinaeum. Was taken to see Dr. Mathie, who finding himself unable to pass a catheter, sent him at once to the Infirmary.

Was seen at about 7 p.m. by Dr. R., who also failed to pass a catheter, and found a rather sharply defined swelling in the perinaeum, with ecchymosis extending upwards on the abdomen half way to the umbilicus, and also some way down on the thighs in front.

The bladder was much distended, dulness extending to midway between symphysis and umbilicus.

Suprapubic drainage was established as in the previous cases, and on the morning of the 18th September patient was put under chloroform, the swelling incised, and the urethra dealt

with as in case I., a guide introduced through the suprapubic puncture being found of service. The injury seemed to be in front of the triangular ligament.

Two catgut sutures were used to bring the ends of the urethra together, and the wound in the perinaeum partly closed.

In spite of the fact that two catheters were used (suprapublically and per urethram), drainage in this case was not quite satisfactory; some urine escaped by the perinaeal wound and caused much pain to the child. On the 22nd September, after his temporary absence for a few days, Dr. R. readjusted the catheters, and thereafter the patient was kept quite dry. On the 27th, the suprapubic catheter was taken out, and on the following day the urethral one.

Dismissed 21st October, passing water freely, but with a tightness at the seat of injury. Nothing more than No. 5-8 could be passed without force.

In the course of the next month patient was seen once or twice, but had to be sent for. His own account of himself was that he was doing well, and the passage of instruments was avoided, in the belief that if stricture was advancing this could not be prevented, that the amount of cicatricial tissue would only be increased, and that it must be dealt with by the more radical procedure of resection.

On the 30th November patient was brought back by his mother with the statement that he had great difficulty in passing water, spent a long time over it, and was wetting his bed at night.

On the first attempt Dr. R. was unable to pass any instrument at all. The bladder was distended, and urine was dribbling away. The turning down of the bedclothes seemed enough to set up contraction of the bladder and produce a fine feeble stream.

*12th December.* Under chloroform Dr. R. was able to pass a whalebone guide; a grooved staff was then passed down on this till it reached the stricture, cut down upon, and the stricture dissected through. The stricturing scar was cut out for about three-eighths of an inch. The ends of the urethra having been dissected free, were brought together with catgut



over a catheter, which was withdrawn at the end of the operation. The tissues over the urethra were brought together by successive layers of catgut sutures, and over this a pad of sponge and gauze tissue was firmly secured.

Before beginning the perinaeal operation the bladder was distended by injection from the meatus, and a suprapubic drain established by passing in a soft catheter through a puncture.

*14th December.* Drainage going on satisfactorily.

*16th December.* Suprapubic drainage continues satisfactory. Some urine has come once by the urethra, and there would seem to have been a little escape by the perinaeum, but the stitches have held, and the wound is in good condition.

*23rd December.* Passing urine from time to time per urethram, some occasionally comes by the perinaeal wound as if the suprapubic drain got displaced. Suprapubic drain withdrawn.

*28th December.* Suprapubic puncture and perinaeal wound both soundly healed. Patient passes urine in a full strong stream.

Examined with bougies; there is found an irregularity opposite the middle of the scar, but bougies slip in easily up to 10-13.

*13th January, 1897.* Patient empties his bladder easily enough, but for last two nights has been found wet in bed by midnight. On being examined to-day bladder is found distended up to umbilicus. It seems as if the bladder had become insensitive, or that its co-ordination had been disturbed by the drainage, but he empties it easily in a good stream.

*18th January.* Sent home.

*8th February.* Bougies 8-11, 9-12 passed with slight hitch. Has to be wakened at night to empty bladder or will pass urine in bed.

*1st March.* 9-12 enters with slight hitch. Makes urine in a good stream.

*24th June, 1897.* 9-12 passed at once without any difficulty.

*October, 1897.* Came up by request for examination. Has no inconvenience. Bougie 9-12 passes easily.

30th June, 1898. Again examined. Makes urine in a good stream. Bougie No. 9-12 passed at once with only such resistance as was experienced before.

*Note.*—While the result in this case has been fairly satisfactory, the patient recovering with a stricture which seems not diminishing in calibre, and which, in the absence of any infection of the urethra, may be expected not to diminish further, I am inclined to think that healing might have taken place more promptly had a catheter been left in the urethra, and I should be inclined to use one in repeating the operation.

# REPORT ON THE CASES ADMITTED TO THE CITY OF GLASGOW SMALL-POX HOSPITAL, BELVI- DERE, DURING THE EPIDEMIC OUTBREAK IN THE YEARS 1892-95.

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It is our object to include within the limits of this report only those cases admitted to the City of Glasgow Small-Pox Hospital, Belvidere, during the epidemic prevalence of small-pox which extended from August, 1892, till December, 1895. During this period the annual admissions and deaths from this disease were as follows:

Year.	Admissions.	Deaths.
1892 . . .	73 . . .	5
1893 . . .	369 . . .	25 <sup>1</sup>
1894 . . .	49 . . .	5
1895 . . .	236 . . .	20 <sup>2</sup>
<hr/>		<hr/>
TOTALS, . .	727	55

In 1892, previous to the occurrence of the outbreak, there was one case of small-pox treated in the hospital, and in the early months of 1896 six cases were under treatment, but as these were independent and imported cases, and had no direct connection with the epidemic, they have been intentionally omitted from our record. Excepting a few treated in Knightswood Hospital, the above statement includes all the cases connected with the outbreak.

<sup>1</sup> One of these cases died of phthisis pulmonalis.

<sup>2</sup> One of these cases died of chronic bronchitis and emphysema.

During the epidemic period there were admitted to the hospital in all 858 persons, of whom 784 were certified to be suffering from small-pox, 66 as suffering from chicken-pox, while 8 were healthy mothers admitted with infants on the breast. Of the total admissions, however, only the above enumerated 727 cases were decided on observation to be undoubted cases of small-pox, the remaining 123 patients suffering from diseases other than small-pox.

The following analysis gives an idea of the miscellaneous diseases admitted:

Disease as Certified on Admission.	Disease as Diagnosed after Admission.	Cases Admitted.	
		Small-Pox.	Others.
Small Pox (784 cases), .	<i>Small-Pox</i> , . . . .	722	...
Do., . . . .	Chicken-Pox, . . . .	...	18
Do., . . . .	Syphilis, . . . .	...	12
Do., . . . .	Nothing, . . . .	...	9
Do., . . . .	Measles, . . . .	...	8
Do., . . . .	Eczema, . . . .	...	3
Do., . . . .	Scabies, . . . .	...	2
Do., . . . .	Febricula, . . . .	...	2
Do., . . . .	Lichen, . . . .	...	2
Do., . . . .	Gangrene { (a) of Leg, . . . . 1 (b) of Penis, . . . . 1 }	...	2
Do., . . . .	Post-Vaccinal Eruption, . . . .	...	1
Do., . . . .	Acute Rheumatism, . . . .	...	1
Do., . . . .	Acute Pneumonia, . . . .	...	1
Do., . . . .	Scarlet Fever, . . . .	...	1
Chicken Pox (66 cases),	Small-Pox, . . . .	5	...
Do., . . . .	Chicken-Pox, . . . .	...	60
Do., . . . .	Syphilis, . . . .	...	1
		727	123
	Nursing Mothers, . . . .	...	8
	TOTAL, . . . .	858	

From this it will be seen that of the 784 cases certified small-pox, 62 (or 7·9 per cent.) were wrongly diagnosed; and of the 66 cases certified chicken-pox, 5 (or 7·6 per cent.) proved to be suffering from small-pox. Besides these mistakes in diagnosis discovered in the Small-Pox Hospital, cases were occasionally admitted to the adjacent Fever Hospital certified



measles, enteric, or typhus fever which were found to be small-pox.

This experience helps to illustrate the difficulty which so frequently attends the diagnosis of small-pox, a difficulty greatest in the early phase of the eruption, or when it presents itself in a modified form; for in the former case the disease is apt to be mistaken especially for syphilis and measles, while in the latter varicella presents the principal element of confusion. In those cases mistaken for measles, enteric, or typhus, the confusion arose from failure to distinguish the prevariolar eruption of the morbilliform and petechio-erythematous types from the exanthem which they simulated.

It was the realization of the above probabilities of confusion that prompted the sanitary authorities to encourage the notification of all cases, especially varicella, which presented any reasonable resemblance to small-pox, and this will naturally occur to the mind as accounting for the large proportion of chicken-pox cases admitted to the hospital. Outside the primary consideration of the public safety, the practice of admitting doubtful cases may be open to theoretical objections, especially when an "observation ward" is not in use; but, as will be seen later on, the experience of the hospital during the epidemic under consideration showed that, as the result of prompt and careful revaccination, any risk fades away to vanishing-point.

We do not intend at present to speak of the preventive measures against small-pox invasion that have been so systematically developed by the responsible authorities in Glasgow, nor do we intend to dwell on the special measures adopted during the actual epidemic prevalence of the disease. But we would point out that the responsibility for the city's preparedness in this respect falls directly upon one executive body—the municipal sanitary department. It is satisfactory that the advances on ancestral methods, both parochial and legislative, in dealing with small-pox, especially those involving the practice of vaccination and revaccination, have earned the confidence of the community generally. Thus vaccination and revaccination, associated with the isolation of patients and suspects in hospital and reception-houses, were utilized to the

ultimate protection against a critical outbreak of small-pox of a population exposed on all sides to the introduction of the disease.

The epidemic commenced by admission into the hospital on August 6, 1892, of a sailor who had recently arrived from Bilbao. On reaching Glasgow he took up his residence in one of the model lodging-houses close to the docks, where he sickened on the 27th July, ten days after leaving Spain. The disease was communicated by this patient to several inmates of the lodging-house in the first instance, and, within ten weeks, there were admitted to the hospital from various quarters of the city, about a dozen associated cases. It was possible, for a considerable time, to trace through sequences of infection the association of fresh cases with the first, but this feature of the outbreak was ultimately lost, partly as a result of the presence of missed cases, and partly from the intrusion of fresh cases from without which set up new centres of infection within the city. The investigations of the sanitary officials as to the origin of each case showed the outbreak to be rich in examples of infection communicated to all classes of the community—"to neighbours, to friends and relatives living at a distance who were casual callers, to fellow-workers, to employers, and to persons during the short and casual relationship of waiting to consult the same doctor."<sup>1</sup>

During the whole course of the outbreak, of the total number of small-pox admissions about 10 per cent. were drawn from the vagrant class—this term being used to indicate frequenters of model lodging-houses, shelters of various kinds, and prisons. The majority of these were removed from model lodging-houses, and were admitted to hospital during the earlier part of the epidemic. The smallness of this proportion is remarkable, considering the origin of the epidemic, and the circumstances and unhealthy relations of this class, and is probably to be accounted for by the large number who had served in the army, or had passed through prisons, poorhouses, and reformatories, and become thereby one of the best protected by vaccination in the community.

<sup>1</sup> Report by the Medical Officer of Health to the Committee on Health Nov., 1892.

Of conditions other than vagrancy and direct contact with infection influencing the maintenance of the disease among the community that due to seasonal causes may be conveniently illustrated in the following table:—

Year.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.
1892 . .	...	...	...	...	...	...	...	3	5	10	38	17
1893 . .	96	42	93	83	47	8	...	...	...	...	...	...
1894 . .	1	6	14	20	5	1	...	...	...	...	...	...
1895 . .	14	52	40	69	31	13	2	1	...	6	4	4

Here the alternate massing and thinning of the cases contemporaneously with obvious changes in meteorological conditions tempts to speculation as to the possible law regulating the undulatory movement observed during the epidemic. It must suffice, however, to point out that these results probably depend on the fact that, during the colder and darker months, overcrowding among the lower classes in a large city like Glasgow constitutes an important factor in the causation and spread of small-pox as of other zymotic diseases, this factor disappearing in direct proportion as the months become sunny and life less domestic.

A more controllable influence, and one which seriously affected the spread of the infection, was connected with the occasional tardiness with which the disease received medical recognition, and, in this connection, it is a matter of considerable interest and importance to note the period elapsing between the admission of the patient to hospital and the commencement of the initial stage of the illness. This period was found to vary within wide limits, some of the cases being admitted as early as the second day of illness, while others were not admitted till the twenty-second day or even later. The majority of the patients entered the hospital on the fourth, fifth, or sixth days of illness, *i.e.* soon after the characteristic eruption appeared; but a considerable number were identified and isolated only when the pustular stage was well advanced,

even though the patients were in some cases under constant medical observation in their own homes. The bulk of those admitted after the fourteenth day were cases "missed" in their earlier stages on account of the mildness of the attack leading the sufferers to think that they had some trifling ailment which did not demand medical advice. These cases were discovered mostly by the medical officers and epidemic inspectors after giving rise to secondary infections. The following scheme shows concisely the admissions as they occurred in relation to the day of illness :—

Day of illness } on admission, }	2nd	3rd	4th	5th	6th	7th	8th	9th	10th
Number admitted,	15	52	137	178	119	83	56	16	12

Day of illness } on admission, }	11th	12th	14th—21st	22nd.	No information.
Number admitted,	4	2	11	16	26

An analysis of the ages of those admitted shows a range from early infancy to advanced age—the great bulk of the cases, however, being persons from 20-40 years. This will be at once appreciated by a reference to the table on page 216, in which the age incidence is set down in annual periods up to five years, in quinquennial periods from 5-20 years, and in decennial periods from 20 years upwards.

It will be noticed that there were admitted in all 38 cases under ten years of age, or 5·2 per cent. of the total admissions. The smallness of this proportion will be better appreciated when it is remembered that, approximately, 24 per cent. of the community is made up of children under ten years. On the other hand, there were admitted 16 cases over fifty years of age, or 2·2 per cent. of the total admissions. This proportion at first sight seems small, but it should be noticed that, approximately, only 12 per cent. of the community is made up of persons of fifty years and upwards. But all these peculiarities of age distribution in small-pox relate mainly to vaccination, and can be discussed correctly only in reference thereto.

The disproportion between the males and females admitted amounted to over a fourth less females than males.

The case mortality over all during the epidemic was 7·6 per



SMALL-POX. TABLE SHOWING ADMISSIONS AND DEATHS AT VARIOUS AGES OF 727 CASES ADMITTED INTO THE CITY OF GLASGOW SMALL-POX HOSPITAL, BELVIDERE.

AGES.	MALES.			FEMALES.			TOTAL.		
	Cases admitted.	Died.	Mortality per cent.	Cases admitted.	Died.	Mortality per cent.	Cases admitted.	Died.	Mortality per cent.
Under 1	5	2	40·00	1	1	100·00	6	3	50·00
1-2	...	...	...	1	...	...	1	...	...
2-3	5	...	...	1	...	...	6	...	...
3-4	1	...	...	...	...	...	1	...	...
4-5	3	...	...	1	...	...	4	...	...
Total Under 5, }	14	2	14·28	4	1	25·00	18	3	16·67
5-10	12	...	...	8	2	25·00	20	2	10·00
10-15	20	1	5·00	27	...	...	47	1	2·13
15-20	56	...	...	51	...	...	107	...	...
20-30	179	10	5·59	114	10	8·77	293	20	6·82
30-40	100	14	14·00	62	2	3·23	162	16	9·88
40-50	37	5	13·52	27	4	14·82	64	9	14·09
50 upwards }	9	3	33·34	7	1	14·29	16	4	25·00
Total over 5, }	413	33	7·99	296	19	6·42	709	52	7·34
Totals,	427	35	8·20	300	20	6·67	727	55	7·57

cent., the larger proportion of deaths being among the males, the percentage of fatality among males as compared with females standing as 8·2 to 6·7 per cent.

*Vaccination Statistics of Cases of Small-pox admitted to the Hospital during the Outbreak.*—The following table gives details as regards vaccination, revaccination, the character of the eruption, and the result in all cases of small-pox admitted during the course of the epidemic. Of the 727 cases admitted 643 were vaccinated, 12 being revaccinated in later life. Of these 23 died. Of unvaccinated cases there were 63 admissions with 27 deaths, while in 21 cases the evidence as regards vaccination was doubtful, and of these 5 died.

AGE PERIODS.	SMALL-POX IN UNVACCINATED PERSONS.				SMALL-POX IN FULLY VACCINATED PERSONS.				SMALL-POX IN PERSONS ONCE VACCINATED.												FOUR SCARS.				SMALL-POX IN RE-VACCINATED PERSONS.				TOTALS.																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																						
	Nature of Attack.		Deaths.		Nature of Attack.		Deaths.		ONE SCAR.			TWO SCARS.			THREE SCARS.			FOUR SCARS.			FOVE-ATED.			FOVE-ATED.			Discrete.																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																								

\* Four of these cases were vaccinated during incubation period. † One of these cases had small-pox in infancy. ‡ One of these cases was vaccinated during incubation period.  
 § One of these cases died of pithitis pulmonalis. || Died of chronic bronchitis and emphysema.

While these figures give a general idea of the state of vaccination, mortality, etc., it will be shown that they require to be considerably modified to bring out the exact truth, especially as regards the mortality among the vaccinated and unvaccinated cases. Of the 23 deaths occurring among vaccinated persons, two were the result of diseases other than small-pox, the attack of small-pox in each case being mild. In one death was due to chronic bronchitis and emphysema, and the other was the result of phthisis pulmonalis. This leaves 21 (or 3.26 per cent.) deaths among vaccinated persons directly due to small-pox. It is of interest to note that none of the deaths occurred among revaccinated persons.

In the above table all cases unvaccinated *at the time of exposure to infection* appear in the column of "unvaccinated cases," but five of these were successfully vaccinated within a short time *after* exposure. In four of these the attack was very mild, and there is every reason to believe that the course was greatly modified by the process of vaccination. This opinion is based upon the extremely mild character of the attack in most of the cases so vaccinated as compared with that in those in whom no attempt at vaccination had been made, or in whom the attempt had failed. In three of the cases vaccination was performed from the tenth to twelfth day before the appearance of the eruption, in another after exposure to infection, but no information could be given as to the actual date, while in the remaining case the operation was performed on the eighth day before the appearance of the eruption, but apparently without exerting any modifying influence on the course of the attack, as the child died on the twelfth day of illness of confluent small-pox. In addition to the above, one of the unvaccinated cases had had small-pox in infancy, and presented on admission numerous pock-marks on the face and extremities. Thus we are left with 57 cases in which absolutely no attempt to vaccinate was made either before or after exposure to infection, and in which no protection was conferred by a previous attack of small-pox.

Under the heading "doubtful" are classed all cases where the patient was said to have been vaccinated in infancy, but

of which no evidence could be discovered, either as a result of defective vaccination or masking of the cicatrices by a profuse eruption. Of the 21 cases so classed one had a previous attack of small-pox in early adult life. This leaves us with 20 cases in which there was no evidence of previous protection.

Comparing the rate of mortality of these unquestionably non-vaccinated, doubtfully vaccinated, and vaccinated cases, we get the following result:—

	Cases.	Died of Small-Pox.	Mortality per cent.
Unvaccinated, . . .	57 .	26 .	45·6
Doubtful, . . .	20 .	5 .	25·0
Vaccinated, . . .	643 <sup>1</sup> .	21 .	3·3

In other words, the rate of mortality of unvaccinated cases was about fourteen times that of the vaccinated, and nearly double that of the doubtful cases; while the rate of mortality among doubtful cases was about eight times that of the vaccinated cases.

Comparing the rate of mortality among vaccinated and unvaccinated persons according to age, and excluding the two deaths among the vaccinated due to phthisis and chronic bronchitis, the five cases vaccinated while incubating the disease, and the unvaccinated case which had had a previous attack of small-pox, we get the following result:

AGE- PERIODS.	VACCINATED.			UNVACCINATED.		
	Cases.	Deaths from Small-Pox.	Mortality per cent.	Cases.	Deaths from Small-Pox.	Mortality per cent.
0-5	6	...	...	5	2	40·0
5-10	10	...	...	8	1	12·5
10-15	43	...	...	4	1	25·0
15-20	103	...	...	3	...	...
20-30	270	11	4·07	15	6	40·0
30-40	144	6	4·16	14	9	64·2
40+	67	4	6·0	8	7	87·5

Here it is of especial interest to observe that, among the vaccinated cases, no death occurred among 162 cases treated under the age of twenty years, whereas among 20 unvaccinated

<sup>1</sup> Includes the 12 revaccinated cases.



persons during the same period there were 4 deaths (or 20 per cent.), and this startling disproportion between the rate of mortality among vaccinated and unvaccinated persons is maintained as we advance in the age-periods.

Passing now from the consideration of the influence of vaccination upon the rate of mortality in small-pox, we will next consider what influence vaccination exerts upon the severity of the attack in so far as that can be gauged by the character of the eruption as set forth in the subjoined table, from which, for obvious reasons, we omit all reference to "doubtful" cases.

AGE-PERIODS.	VACCINATED.						UNVACCINATED.					
	Nature of Attack.			Percentages. <sup>1</sup>			Nature of Attack.			Percentages. <sup>1</sup>		
	Discrete.	Con-fluent.	Haemor-rhagic.	Discrete.	Con-fluent.	Haemor-rhagic.	Discrete.	Con-fluent.	Haemor-rhagic.	Discrete.	Con-fluent.	Haemor-rhagic.
0-5	6	...	...	100	...	...	...	4	...	...	100	...
5-10	8	2	...	80	20	...	3	5	...	37·5	62·5	...
10-15	43	...	...	100	...	...	1	3	...	25	75	...
15-20	111	2	...	98	2	...	1	2	...	33·3	66·6	...
20-30	251	16	3	93	6	1	1	11	3	6·6	73·4	20
30-40	132	11	1	92	7·5	0·5	1	10	3	7	72	21
40 +	57	7	3	85	10	5	2	5	2	22·2	55·6	22·2
Totals,	608	38	7	93	6	1	9	40	8	15·8	70·2	14·0

Comparing the totals we find that, among 653 vaccinated persons, 608 (or 93 per cent.) presented a discrete eruption, while, among 57 unvaccinated persons, there were only 9 (or 15·8 per cent.) whose illness was of this comparatively mild type.

Turning now to the severe types of the disease, we find that only 38 (or 6 per cent.) of "confluent" and 7 (or 1 per cent.) of "haemorrhagic" cases existed among the vaccinated; while among the unvaccinated there were as many as 40 (or 70 per cent.) of the former type, and 8 (or 14 per cent.) of the latter. Again, on massing and comparing the cases under the age of twenty when presumably primary vaccination still exercises a

<sup>1</sup> Percentages of Total at each Age-Period.

modifying influence over the course of the disease, we find that of 162 vaccinated persons, only 4 (or 2·4 per cent.) were "confluent," while, of 19 unvaccinated, 14 (or 74 per cent.) were of this type. This difference is too striking to require further comment.

Setting aside for the present the unvaccinated cases and comparing the proportions of confluent cases occurring among the vaccinated only in the age-periods above twenty years, we find a steady increase in the proportions, the figures being as follows: 20-30 years, 6 per cent.; 30-40 years, 7·5 per cent.; over 40 years, 10 per cent., suggesting a gradual but steady decrease of the protection afforded by primary vaccination. What part, if any, is played by increasing age in the evolution of these figures would be very difficult to say, but it is noteworthy that, in comparing them with the same age-periods among the unvaccinated, we find the order reversed—the largest proportion of confluent cases occurring during the age-period 20-30 years—the sequence of the proportions being 73·4, 72 and 55·6 per cent. for each of the age-periods above twenty years. Doubtless the numbers on which the latter proportions are calculated (see table above) are small, but they are nevertheless very suggestive.

We would point out that among vaccinated persons a "confluent" eruption does not necessarily indicate a violent type of the disease, for in a number of cases the confluent eruption aborts before the pustular stage is reached, and in some cases part only of the elements of the eruption become even markedly vesicular. This is a condition we have never observed among unvaccinated confluent cases.

Proceeding now to investigate the protective influence of vaccination as indicated by the area and character of the scars among those only once vaccinated, we will find in the table on page 222 facts of a most suggestive kind. These measurements were invariably made at the time of dismissal of the patient from hospital.

Comparing in the first place the "foveated" with the "nonfoveated," we have to deal with a total of 503 of the former and 128 of the latter. The protective influence of vaccination as indicated by a "foveated" scar would appear

AREA OF CICATRIX.	FOVEATED.				UNFOVEATED.				TOTALS.				
	Discrete.	Confluent.	Haemorrhagic.	Died.	Discrete.	Confluent.	Haemorrhagic.	Died.	Discrete.	Confluent.	Haemorrhagic.	Died.	
Class I.— Under $\frac{1}{4}$ sq. in.	29	4	1	3	18	8	3	6	47	12	4	9	
Class II.— $\frac{1}{4}$ to $\frac{1}{2}$ sq. in.	132	9	...	6	28	4	...	3	160	13	...	9	
Class III.— Over $\frac{1}{2}$ sq. in.	318	9	1	2	61	4	2	4	379	13	3	6	
TOTALS,	479	22	2	11	107	16	5	13	586	38	7	24	
Results in per- centages of total cases in each class.	Cl. I.	85.0	12.0	3.0	8.8	62.0	27.6	10.4	20.7	74.6	19	6.4	14.3
	Cl. II.	93.6	6.4	...	4.3	87.5	12.5	...	9.4	92.5	7.5	...	5.2
	Cl. III.	97.0	2.7	0.3	0.6	91.0	6.0	3.0	5.9	96.0	3.3	0.7	1.5
TOTALS,	95.0	4.5	0.5	2.2	83.6	12.5	3.9	10.2	92.8	6.0	1.2	3.8	

to be much greater than that represented by an unfoveated scar, for while among the former we find only

11 deaths, or a proportion of 2.2 per cent.

2 haemorrhagic cases, or a proportion of 0.5 per cent.

22 confluent cases, or a proportion of 4.5 per cent.,

among the latter these proportions are greatly increased, there being

13 deaths, or a proportion of 10.2 per cent.

5 haemorrhagic cases, or a proportion of 3.9 per cent.

16 confluent cases, or a proportion of 12.5 per cent.

The difference noticeable between the proportions of discrete cases belonging to these two classes is equally well marked, there being in the first or foveated class a total of 479 (or 95 per cent.) of discrete cases, and in the second or nonfoveated class 107 (or 83.6 per cent.).

Turning now to the question of scar area, we obtain results which point to the conclusion that the superficial area of the vaccinal cicatrix is an index of the degree of protection

afforded by vaccination. Beginning with 63 cases showing a scar area measuring less than  $\frac{1}{4}$  square inch, we find the total subdivided into 47 (or 74·6 per cent.) discrete cases, 12 (or 19 per cent.) confluent cases, and 4 (or 6·3 per cent.) haemorrhagic cases. Of these cases 9 (or 14·3 per cent.) died. Passing now to those cases with a scar area measuring from  $\frac{1}{4}$ - $\frac{1}{2}$  square inch, we find indications of a greater protective influence, for of a total of 173 cases, we get the large proportion of 160 (or 92·5 per cent.) discrete cases, while the proportion of severe cases is considerably reduced, there being 13 (or 7·5 per cent.) confluent cases, and no haemorrhagic cases. In this second class there were only 9 deaths (or 5·2 per cent.). Finally, when we investigate those cases, of which there was a total of 395, in which the scar area exceeded  $\frac{1}{2}$  square inch, we find no fewer than 379 (or 96 per cent.) discrete cases, only 13 (or 3·3 per cent.) confluent cases, and 3 (or 0·7 per cent.) haemorrhagic cases. Of the total of 395 cases belonging to this class only 6 (or 1·5 per cent.) proved fatal. The influence of the larger scar area and its index for protection is brought out most markedly when we contrast the first and third classes. In the former, with a scar area under  $\frac{1}{4}$  square inch, we have 21·4 per cent. *fewer* discrete cases, and 15·7 per cent. and 5·6 per cent. *more* confluent and haemorrhagic cases respectively. The disproportion between the death rates is equally marked, there being 12·8 per cent. *more* deaths in the first than in the third class.

Continuing our analyses, we have next to consider the influence of vaccination in so far as it depends on the *number* of scars, and the table on page 224 is intended to give some idea of the importance of this.

The most striking feature here is the great proportion of discrete as compared with confluent cases irrespective of the number of scars. The disproportion between the total number of cases with three or more scars as compared with those having one or two scars would suggest a much greater protective influence conferred by the former as against a lesser number.<sup>1</sup> Less striking, but still very obvious, is the influence

<sup>1</sup> The obvious fallacy which may exist here is that the number of persons in the community having one, two, three or more scars is unknown.



Number of Scars.	Discrete Cases.	Confluent and Haemorrhagic Cases.	Deaths.
Class I.—One Scar, . . .	266	29	17 <sup>1</sup>
Class II.—Two Scars, . . .	247	12	5
Class III.—Three Scars +, . . .	73	4	1 <sup>2</sup>
Totals, . . . . .	586	45	23
Results in Percent-ages of total cases in each class,			
Class I.,	90·2	9·8	5·8
Class II.,	95·4	4·6	2·0
Class III.,	95·0	5·0	1·3
Totals, . . . . .	92·9	7·1	3·6

of two scars and upwards as compared with one, a fact brought out not only by the increase in the proportion of discrete cases with an increase in the number of scars, but also by a progressive diminution in the proportion of confluent cases and deaths under the same influence.

The duration of a patient's illness from small-pox is to some extent a gauge of the severity of the attack, and hence the length of a patient's illness, calculated from the first onset of the initial symptoms till the date of dismissal from hospital, may be used to give at least general data as to the mildness or otherwise of the attack. It should be noted in this connection, however, that it is the practice of the hospital to detain even those suffering from the mildest forms of the disease till the twenty-eighth day from the first onset of symptoms. Of the total 727 recorded cases the date of the initial illness was available in all but seven. Taking the remaining 720 cases and classifying them according to their condition as to vaccination (see table, p. 217), we get the following information regarding the mean duration of the attack among those who recovered as well as among those ending fatally:

	LENGTH OF ILLNESS.		
	Vaccinated.	Doubtful.	Unvaccinated.
Recoveries, . . .	38·3 days . . .	51 days . . .	59·6 days
Deaths, . . .	12·7 „ . . .	14·3 „ . . .	12·3 „

<sup>1</sup> One of these deaths was due to phthisis pulmonalis.

<sup>2</sup> This case died of bronchitis and emphysema.

Here it will be observed that the "vaccinated" had an average duration of illness of almost two weeks less than the "doubtful," and rather over three weeks less than the "unvaccinated," while among the fatal cases the average duration of the illness was about the same in each class—the majority of the patients dying at the end of the second week of illness, a period corresponding with the acme of the attack. The approximate identity of these mortality figures in the different classes suggests the question whether the reduction of the "vaccinated" and "doubtful" to the same level with the "unvaccinated" does not point in the direction of a complete loss of the protective influence of vaccination among the first of those so far as fatal cases are concerned.

*Revaccination.*—Of the total admissions to hospital during the epidemic period only 12 were cases showing unmistakable signs of successful revaccination, though a number were admitted in whom revaccination was said to have been attempted on one or more occasions, but without success. Among the former the ages ranged from 20 to 45 years, 3 being persons between 20 and 30 years, 5 between 30 and 40 years, and 4 between 40 and 45 years. One of these patients had been revaccinated 38 years before admission, another 32 years, three 21 years, while the remaining seven were revaccinated 20, 16, 14, 13, 11, 10, and 7 years respectively before contracting small-pox. Each of these cases showed unequivocal and well-defined cicatrices, due to their secondary vaccination. All were, without exception, mild cases and recovered, the average duration of illness being 35 days.

In addition to these there were 13 cases admitted in whom revaccination had proved unsuccessful, and in each of these, with but two exceptions, the attempt to revaccinate was *recent*, and performed as a *prophylactic during the course of the epidemic*. With regard to the two cases mentioned as exceptions, there was no evidence of the operation beyond the patients' statements; among the others, in three cases there were distinct local signs of reaction; but in the remaining eight no local effect followed upon the operation. It would seem that, in some of these cases, the failure of the revaccination was regarded as evidence of immunity, but the subsequent develop-

ment of small-pox showed clearly that such immunity did not exist. The following table gives a short abstract of the more important data concerning the 11 cases referred to as unsuccessfully revaccinated:

Age.	Statement as to Primary Vaccination.	Interval between attempted Re-vaccination and attack of Small-Pox.	Lymph used and Result.	Character of Small-Pox Attack.
Years. 20	1 good scar dating from infancy.	21 days.	Conserve calf-lymph: no reaction.	Sparse eruption.
25	Said to have been done in infancy, but no scar visible.	Do.	Do., do.	Do., do.
26	2 good scars dating from infancy.	22 days.	Conserve calf-lymph: slight local reaction.	Rare eruption.
16	3 good scars dating from infancy.	30 days.	Conserve calf-lymph: no reaction.	Sparse eruption.
35	Do., do.	1½ months.	Human & calf-lymph (several attempts): slight local reaction.	Rare eruption.
21	1 small scar dating from infancy.	2½ months.	Human lymph: no reaction.	Sparse eruption.
45	2 good scars dating from infancy.	3 months.	No information regarding lymph: no reaction.	Sparse eruption.
29	1 good scar dating from infancy.	3½ months.	Conserve calf-lymph: no reaction.	Copious eruption.
29	Do., do.	15 months.	Conserve calf-lymph: slight local reaction.	Rare eruption.
66	2 small scars dating from infancy.	16 months.	No information regarding lymph: no reaction.	Sparse eruption.
22	4 small scars dating from infancy.	36 months.	No information regarding lymph: no reaction.	Rare eruption.

It seems to us important to observe that the conserve of calf-lymph employed in these cases was supplied by certain makers under an unusual strain on their resources, and probably this accounts to some extent for the unsatisfactory results obtained. The unreliable quality of this proprietary calf-lymph led us to practise in all cases of urgency vaccination with fresh humanized lymph which had undergone only a few removes from the calf.

We now come to the consideration of revaccination *after exposure to infection*. Taking thirteen days as fully representing the time occupied in the process of incubation among

the small-pox cases under discussion, the epidemic supplied us with 68 cases in which revaccination had been performed within this period. The interval between the date of attempted revaccination and the commencement of the initial symptoms of small-pox varied from 1 to 13 days, and, if this period of incubation be subdivided so that the effects of revaccination are considered within periods of 1 to 4 days, 5 to 8 days, and 9 to 13 days of sickening, we get the following results:

Length of time before Initial Symptoms of Small-Pox.	Negative Result.	Slight Local Reaction.	Apparently Successful Vaccinia.	Totals.
Class I.—1-4 days, . . .	16	7	...	23
Class II.—5-8 " . . .	5	14	3	22
Class III.—9-13 " . . .	8	9	6	23
Totals, . . . . .	29	30	9	68
Results in percentages of Total Cases in each Class.				
Class I.	69·6	30·4	0·0	...
Class II.	22·8	63·6	13·6	...
Class III.	34·8	39·1	26·1	...
Totals, . . . . .	42·7	44·1	13·2	...

Admitting that some of the samples of calf-lymph conserve used in revaccination were not altogether trustworthy, that the skill of the operators was not always perfect, and also that to a certain extent we are ignorant as to the conclusions to be deduced from the feeble result which so often follows revaccination, we still find from the above record of *successful revaccinations* that the proportion diminishes as we approach the commencement of the initial symptoms of variola—a fact which is of great significance in studying the influence of small-pox upon the local manifestations of vaccinia. The practical deduction from these facts is that we are encouraged to revaccinate even up to the eighth day after exposure to infection. The reasonableness of supposing that successful vaccinia running its course concurrently with the initial stages of small-pox will favourably modify the latter disease is borne out by our clinical



experience. This, expressed in general terms, was that of those in Class I., 26 per cent. were severe cases, those of a similar type in Class II. being reduced to 18·5 per cent., while in Class III. the proportion was as low as 13 per cent.

Before concluding this section of our paper, we consider it legitimate to say a word regarding the extraordinary immunity enjoyed by a community thoroughly protected by *recent* successful revaccination. During the period embraced within the limits of this report there were associated at various times with the hospital a total of no less than 456 persons in addition to the 727 suffering from small-pox. Of these 96 were officials of the hospital and 131 patients suffering from diseases other than small-pox, all living within the hospital precincts, and therefore in daily contact either with the patients themselves or with their infected clothing; while 229 students, physicians, etc., were only occasional visitors. In addition to these, 3 persons entered the precincts of the hospital, but did not come into contact either with the patients themselves or their infected clothing. Of these one was a tradesman who refused revaccination and afterwards entered the hospital without permission of the officials; the second was an ambulance driver belonging to the adjacent fever hospital who occupied a room contiguous to that used by some of the male servants of the small-pox hospital, while the third was a young woman who visited the matron with regard to a vacant situation. Of the above total of 459 persons, 454 had been successfully revaccinated or were regarded as immune on account of failure to revaccinate, one had had small-pox in earlier life, while 4 were persons who had been primarily vaccinated only. Of the 459 persons referred to, 7 contracted small-pox. These included the 4 persons once vaccinated, 2 who were regarded as immune on account of failure to revaccinate, and one who had been successfully revaccinated twenty years previously. With one exception, that of a male aged thirty, who had been vaccinated in infancy only, all these cases were extremely mild, and none died. It is satisfactory as well as interesting to note that no case of small-pox occurred among those who had been successfully revaccinated within a recent date.

## SUMMARY OF CLINICAL COMPLICATONS AND SEQUELAE.

Having now discussed in some detail the general clinical features manifested by the variolous patients admitted to the hospital during the epidemic, our record will tend to completeness if we refer briefly to the rarer complications and sequelae.

The complications and sequelae were observed almost exclusively in the severe types of the disease. Of these boils, abscesses of various sizes, cellulitis and periostitis were most frequently met with. Catarrhal conditions of the bronchial tubes, catarrhal pneumonia, and lobar pneumonia were not exceptional. Gangrene of the lungs occurred in several cases, and pleurisy in a few. Empyema was not met with in any case. Organic cardiac complications were very rare, only one case of acute endocarditis being attributable to the small-pox attack; but loud functional murmurs were very commonly present, especially in the more severe types of the disease. These latter mostly disappeared as convalescence became established. Albuminuria occurred in a considerable number of cases, though actual organic disease of the kidney in only a few, two cases only being dismissed from hospital with persistent albuminuria. In a considerable number of the more severe cases, marked oedema of the lower limbs, without evidence of either renal or cardiac implication, persisted for a time after the patients were allowed to get about. Inflammation of the veins of the legs occurred in three cases. Phlyctenular ophthalmia and mild ulcerative conditions of the eye were not uncommon, but only one patient lost the sight of an eye.

Nervous sequelae showed themselves in three young male adults; in two this took the form of mental disturbance, while the third was probably a form of peripheral neuritis. In one of the former the aberration occurred during early convalescence, when the patient manifested more or less maniacal symptoms with delusions. The second case presented symptoms of post-febrile dementia. Both ultimately recovered after a term of residence in an asylum. The third case was that of a patient, aged twenty-five, vaccinated, and with a sparse eruption, who, in early convalescence (tenth day of illness), complained of

weakness and numbness in the right arm and of tenderness in the shoulder-muscles and biceps. On examination there was distinct paresis of the muscles of the arm and extensors of the forearm, but sensation was unimpaired. The muscular weakness gradually became more marked till about the nineteenth day of illness, when improvement set in, and continued till patient's dismissal on the thirty-sixth day of his illness, at which time there were still distinct signs of diminished muscular power. There was no opportunity of examining the affected muscle electrically.

One of the most serious complications which had to be dealt with was connected with the pregnant state. Among a total of 261 women over 15 years of age admitted to the hospital, 23 (or almost 9 per cent.) were more or less advanced in pregnancy, and of these pregnancies 9 (or 39 per cent.) ended either in abortion or in premature labour. The mortality among those once vaccinated in infancy was about 20 per cent. (4 deaths among 21 cases), while in the only two unvaccinated cases death followed on the abortion.

In all the cases which proved fatal, the eruption was of the confluent type, but in the three that recovered it was only sparsely distributed. These benign cases had been revaccinated shortly after exposure to infection and each showed a mild concurrent vaccinia. Death of the mother and foetus occurred in the two unvaccinated subjects about the third and fifth month respectively, and at the fourth, sixth, seventh, and eighth month respectively in the vaccinated. The three non-fatal cases aborted about the fourth month of pregnancy. In two of these latter the abortion occurred on the twenty-seventh and twenty-eighth day of illness respectively, while the third took place during the prodromal stage. Of the fatal cases one aborted in the prodromal stage and the rest during the period of suppuration (seventh to twelfth day of illness). In only one instance was the infant born alive, viz. at the seventh month and on the twelfth day of the maternal illness. This infant lived for five days, and was vaccinated shortly after birth, but without success.

The 14 pregnant women who did not abort or miscarry had each been vaccinated in infancy, and all recovered. In

only four instances was the eruption other than sparse or rare in amount. The majority of these pregnancies, viz., ten were at the seventh or eighth month of gestation, the remaining four being from the fourth to sixth month.

Besides the above there were 4 women admitted in the early puerperal state. These patients had been vaccinated in infancy and now suffered from modified attacks of small-pox, from which they recovered. In each instance labour had coincided with the occurrence of the prodromal symptoms of the disease. All the infants were lost: one being born dead a little before full term, two though born at natural time only survived birth by a few hours, and one died of inanition and gangrenous inflammation of the right leg nineteen days after birth. This last was vaccinated a few hours after birth, but as the attempt showed no definite reaction after four days the operation was repeated, and was followed by the ultimate success of both attempts.

Many marked examples of the induction of irregular menstruation and metrorrhagia as a result of the attack of small-pox occurred in the experience of the female wards.

No.	Sex and Age.	Vaccinated or Not.	Character of Eruption.	Day of illness when first inoculated.	Total Quantity of Serum Employed.	Termination.	Remarks.
1	Male, 22	In infancy	Copious	5th	30 c.c.	Recovery	{ Urticaria 7 days after infection: "pitting."
2	Male, 20	Do.	Sparse	5th	10 c.c.	Recovery	
3	Female, 55	Do.	Copious	6th	30 c.c.	Recovery	
4	Male, 21	Do.	Copious	6th	20 c.c.	Recovery	"Pitting."
5	Female, 25	Unvaccinated	Haemorrhagic	6th	40 c.c.	Death	{ On 9th day of illness.
6	Male, 33	In infancy	Copious	5th	20 c.c.	Recovery	{ Boils and abscesses during convalescence: "pitting."
7	Male, 16	Do.	Copious	4th	20 c.c.	Recovery	

*Treatment.*—The only interest in this connection centres round a few experiments carried out with the object of demonstrating the therapeutic value of "variola antitoxic serum."



Details of these observations have already appeared elsewhere,<sup>1</sup> the table on page 231 being but a short summary of the cases so treated.

The conclusion arrived at was, in brief, that the serum, in small doses, such as employed by us, in no way modified the course of the attack; and that any therapeutic effects likely to result from this form of treatment must follow upon the administration of large doses, say from 20-30 oz. of serum as at present prepared.

*Summary of Post-Mortem Examinations.*—These examinations were conducted partly by members of the medical staff of the hospital, but principally by Drs. Sutherland and Ferguson, assistants to the Professor of Pathology in the University. In the great majority of the cases death was distinctly traceable to cardiac failure, the internal organs showing almost without exception evidence in a greater or less degree of passive hyperaemia. This was especially evident in the lungs where hypostatic congestion with oedema, and sometimes consolidation of the lower lobes, was present in almost every instance. In addition to these pathological changes directly due to small-pox itself, and more or less present in every case, there were present in some of the cases tissue change which might be regarded more distinctly as complicative, *e.g.* pneumonia, etc., and yet others, *e.g.* phthisis, present probably long before the attack of small-pox commenced, and which must be regarded rather as concurrent conditions than complications. What part these latter played in the course of the disease it is difficult to say, but there seems little doubt that the chances of recovery of a patient handicapped by these concurrent conditions were distinctly diminished. It is worthy of note that the majority of patients so handicapped were vaccinated subjects.

In none of the examinations did the *heart* show any evidence either of endo- or pericarditis, but effusion of serum into the pericardial sac, sometimes in considerable quantity, was not infrequent. Punctiform haemorrhages under the pericardium and endocardium were commonly found in the haemorrhagic cases. In only one case was there distinct naked-eye evidence of degeneration of the cardiac muscle. In several cases atheroma of

<sup>1</sup> *Scottish Medical and Surgical Journal*, 1897, Vol. i. p. 679.

the aorta and its valves with *calcareous* degeneration was present. Dilatation of the cavities, especially those of the right side, was not infrequent.

Distinct evidence of pleurisy was present in four cases, but only in one of these were there indications of purulent change in the fluid.

In several cases slight hydro-thorax was present. Lobar pneumonia, in the stages of red and grey hepatization, was found in four cases, and catarrhal pneumonia in seven, the lesion varying from a few scattered patches of consolidation up to an extent involving practically a whole lobe or even more.

Gangrene of the lungs occurred in only two cases, and took the form of numerous ragged cavities, practically riddling the lungs and varying in size up to  $1\frac{1}{2}$  in. in diameter. These cavities apparently originated in catarrhal patches connected with the ultimate bronchial distribution, probably primarily caused by insufflation of putrid particles. Concurrent tubercle of the lungs was found in eight cases, in several of these cavities were present, in others cicatrices and calcareous masses; of these six were vaccinated and two unvaccinated. In the two unvaccinated cases there was distinct evidence of glomerular nephritis. Fatty liver was frequently noted.

In none of the cases was there anything found in the brain or meninges, and in none of the other organs was anything worthy of note found beyond what has already been referred to.

# A CONTRIBUTION TO THE PATHOLOGY OF THE CORONARY ARTERIES OF THE HEART,

BASED UPON AN ANALYSIS OF 238 CASES IN WHICH THE  
CONDITION OF THESE ARTERIES WAS ASCERTAINED  
AFTER DEATH; WITH OBSERVATIONS UPON THE  
RELATIONSHIP OF DISEASE OF THESE VESSELS TO  
SUDDEN DEATH AND ANGINA PECTORIS.

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IN this paper I propose to give a short analysis of the notes I have preserved of 238 cases in which the coronary arteries of the heart were carefully examined by splitting them up to their terminal branches, and the appearances observed recorded. During the six years that I acted as Pathologist to the Glasgow Royal Infirmary it was my routine practice to examine these arteries, although the result of such examination was not always noted, but in the present paper I shall deal only with those cases concerning which definite statements as to the condition of the coronary arteries have been entered in the report.

Of the 238 cases here dealt with, the coronary arteries were found to be healthy in 136, and diseased, *i.e.* atheromatous, or calcified, or occluded, in 102. No attempt will be made in this paper to tabulate the amount of disease in the coronary arteries, in all cases it was such as to be distinctly visible to the naked eye. The subdivision into healthy and diseased gives us a primary basis of classification.

## I. CORONARY ARTERIES HEALTHY—136 CASES.

Of these cases obviously there is not a great deal to be said. It becomes at once clear that the only point of interest in

reference to them is to determine in how many of them the heart was otherwise healthy, and in those cases where the heart was diseased in other respects to state the character of the lesion. This may be best shown in a tabular form, as follows :

A. *Heart noted to be healthy*, - - - 61 cases.

B. *Heart noted to be diseased*—

(1) Hypertrophy and dilatation,	20 cases.
(2) Aortic valve disease, - -	12 „
(3) Mitral and aortic disease, -	2 „
(4) Simple hypertrophy of left ventricle, - - -	19 „
(5) Fatty infiltration of heart, -	8 „
(6) Fatty degeneration of heart,	1 „
(7) Mitral disease, - - -	6 „
(8) Pulmonary stenosis, - -	1 „
(9) Pericarditis, - - -	2 „
(10) Fibroid disease, - - -	4 „
	<hr/> 75 „

Total, - - - - 136 cases.

In this table I have included, for purposes of classification, merely the predominating lesion of the heart, and the only addition I wish to make to it is a statement of the number of cases in which fatty metamorphosis was also found to be present, as obviously this is a condition which is believed to have a special relationship to disease of the coronary arteries, and may exist along with other lesions. In the table are included 9 cases in which fatty change was the only lesion. In addition there fall to be added 4 cases in which fatty change complicated other lesions, making a total of 13 cases of fatty heart in which the coronary arteries were found to be healthy.

With regard to the condition of the aorta, I have also to add that of the 136 cases of healthy coronary arteries there were 17 in which the aorta was recorded to have been in a state of atheroma.



*Cases of Cardiac Pain, or Angina Pectoris without Disease of the Coronary Arteries.*

Among the cases of healthy coronary arteries there were at least four, concerning which the clinical summary recorded the presence of cardiac pain, probably of the nature of angina pectoris, as a notable symptom. A very brief summary of these four cases, in two of which the term angina pectoris is actually used in the clinical summary, may now be given.

(1) A wood-carver, aged 54, had been breathless for ten years. A week before his admission he felt severe pain in the chest, and for three days before it he had frequent attacks of angina pectoris. He only lived for three days after coming into hospital. In this case the coronary arteries were found to be quite healthy, but there was marked stenosis both of the mitral and the aortic orifices, and the muscular tissue of the left ventricle was beset with numerous fibrous scars, probably of embolic origin.

(2) A domestic servant, aged 19. Her illness began four months before admission with severe cardiac pain and breathlessness, repeated at intervals until her death. Latterly there was dropsy of the lower limbs, enlargement of the cardiac area, feeble sounds without murmur, and irregular action of the heart. In this case the valves and the coronary arteries were quite healthy, but there was thrombosis of the superior vena cava and of the left ventricle. The heart was generally enlarged, weighing 16 ounces.

(3) An iron-moulder, aged 61. In this case cardiac pain was a well-marked symptom. The coronary arteries were quite healthy, but there were thickening and calcareous infiltration of the aortic curtains and dilatation of the aortic orifice. The muscular tissue of the heart was pale and soft.

(4) A carter, aged 44. Had severe attacks of angina pectoris, with great breathlessness. The pain extended to each side of the face, passed down both arms and legs, and was accompanied by a sense of impending death. He died during an attack of extreme breathlessness. He had been ill altogether for about a year, and well-marked V.S., V.D. murmurs were present. Fibroid disease of the heart-muscle was well

marked, and the whole heart was greatly enlarged, weighing 29 ounces. There was atheroma with dilatation of the arch of the aorta. The coronary arteries were healthy.

## II. CORONARY ARTERIES DISEASED—102 CASES.

In analyzing the 102 cases in which the coronary arteries were recorded to be diseased, I shall subdivide them into two groups, viz.: (a) Cases in which there was no fibroid disease (fibrous transformation) of the heart muscle; and (b) Cases in which this change was present. I think this a convenient subdivision, as presenting under one section all the cases of fibroid disease, a lesion frequently, though not so frequently as I formerly thought, associated with coronary artery disease or obstruction.

### (a) *Coronary Arteries Diseased without Fibroid Disease (Fibrous Transformation) of the Heart-Wall—80 Cases.*

It is on the whole somewhat difficult to classify the 80 cases included under this heading, but from a consideration of the records both of the clinical and the anatomical details I have endeavoured to diagnose the predominating, and probably primary, malady, and to class the cases accordingly. This classification is shown in the following table:

TABLE OF PRIMARY OR PREDOMINATING DISEASES.

Disease.	Cases.
Cardiac—Fatty, 3; Mitral and tricuspid stenosis, 1; Aortic valve disease, 5; Arterio-sclerosis, 2; Dilatation and hypertrophy, 7; Pericardial adhesion, 1, - - - - -	19
Renal disease, chiefly chronic tubular or interstitial,	16
Cerebral haemorrhage, - - - - -	8
Cancer—gullet, 3; mamma, 1; stomach, 1; liver, 3; uterus, 1; ovary, 1, - - - - -	10
Pneumonia, acute lobar, - - - - -	6
Bronchitis, 3; bronchiectasis, 2; pleurisy, 1, - -	6
Trauma, - - - - -	6

Leptomeningitis and cerebral softening, - - -	1
Disease of urinary bladder, - - - -	2
Perinephritis, - - - - -	1
Peritonitis, - - - - -	2
Acute miliary tuberculosis, - - - - -	1
Gall-stones, - - - - -	1
Appendicitis, - - - - -	1
Total, - - - - -	80

(b) *Coronary Arteries Diseased with Fibroid Disease (Fibrous Transformation) of the Heart-Wall—22 Cases.*

In classifying the 22 cases under this heading we may proceed as in the tabulation of class (a), *i.e.* the different cases may be numbered under the predominating or primary lesion as judged both by clinical and anatomical details.

TABLE OF PRIMARY OR PREDOMINATING DISEASES.

	Disease.						Cases.
Cardiac—Myomalacia,	-	-	-	-	-	-	4
Thrombosis,	-	-	-	-	-	-	3
Aortic disease,	-	-	-	-	-	-	1
Renal,	-	-	-	-	-	-	3
Pneumonia,	-	-	-	-	-	-	1
Cerebral haemorrhage and thrombosis,	-	-	-	-	-	-	5
Cancer—stomach,	-	-	-	-	-	-	1
Bladder disease,	-	-	-	-	-	-	1
Lumbar abscess,	-	-	-	-	-	-	1
Hodgkin's disease,	-	-	-	-	-	-	1
Syphilis and cardiac,	-	-	-	-	-	-	1
Total,	-	-	-	-	-	-	22

Having thus classified, in such a manner as to show at a glance the principal pathological phenomena, the 238 cases in which notes of the actual condition of the coronary arteries of the heart have been preserved, I propose still further to analyse the records, in order to bring out certain other details which are of interest both to the clinical physician and the pathologist.

## AGE.

(a) *Coronary Arteries Healthy*—136 Cases.

A statement under this heading with regard to age is perhaps hardly necessary, but it may be of interest to compare the results with those obtained in the cases of disease.

	Cases.		Cases.
Under 15 years, -	3	From 50 to 55 years, -	13
From 15 to 20 years, -	5	„ 55 to 60 „ -	11
„ 20 to 25 „ -	1	„ 60 to 65 „ -	20
„ 25 to 30 „ -	8	„ 65 to 70 „ -	4
„ 30 to 35 „ -	7	„ 70 to 75 „ -	1
„ 35 to 40 „ -	19	Unknown, - - -	14
„ 40 to 45 „ -	17		
„ 45 to 50 „ -	13	Total, - - -	136

(b) *Coronary Arteries Diseased, without Fibroid Disease (Fibrous Transformation)*—80 Cases.

	Cases.		Cases.
From 20 to 30 years, -	4	From 65 to 70 years, -	6
„ 30 to 35 „ -	1	„ 70 to 75 „ -	6
„ 35 to 40 „ -	4	„ 75 to 80 „ -	4
„ 40 to 45 „ -	5	„ 80 to 85 „ -	1
„ 45 to 50 „ -	11	Unknown, - - -	4
„ 50 to 55 „ -	10		
„ 55 to 60 „ -	10	Total, - - -	80
„ 60 to 65 „ -	14		

From this table it is at once seen that the largest number of cases occurred between 45 and 65 years of age. Under the age of 45 there were 14, and above 65 there were 21 cases. Coronary artery disease, then, so far as these figures go, is much more commonly met with after the middle period of life.

(c) *Coronary Arteries Diseased with Fibroid Disease (Fibrous Transformation)*—22 Cases.

	Cases.		Cases.
From 35 to 40 years, -	1	From 65 to 70 years, -	5
„ 40 to 45 „ -	1	„ 70 to 75 „ -	2
„ 45 to 50 „ -	2	Unknown, - - -	2
„ 50 to 55 „ -	7		
„ 55 to 60 „ -	1	Total, - - -	22
„ 60 to 65 „ -	1		



Here again it is at once seen that all the cases except two occurred after the age of 45. The table also brings out this additional point, perhaps not of great moment owing to the smallness of the numbers, that where the coronary disease is associated with fibroid disease (fibrous transformation) of the heart-wall the greatest number of cases occurred between the ages of 50 and 70.

If we take the ages of the whole 102 cases in which the coronary arteries were found to be diseased, we find that 86 of them were 45 years of age and upwards, and that only 16 were under 45.

## SEX.

*(a) Coronary Arteries Healthy.*

Of the 136 cases in which, upon examination, the coronary arteries were found to be healthy, 102 were males and 34 females.

*(b) Coronary Arteries Diseased, without Fibroid Disease.*

Males,	-	-	-	-	59
Females,	-	-	-	-	21
					—
Total,	-	-	-	-	80

*(c) Coronary Arteries Diseased, with Fibroid Disease.*

Males,	-	-	-	-	15
Females,	-	-	-	-	7
					—
Total,	-	-	-	-	22

These figures show that of the total cases of diseased coronary arteries the lesion occurred 74 times in males and 28 times in females.

## CONDITION OF THE HEART IN CORONARY ARTERY DISEASE.

Under this heading I shall attempt to show, by means of tables, the frequency with which lesions of the heart, other

than that under which the case may possibly have been classified in my general table, were associated with disease of the coronary arteries. Manifestly the point is important, as integrity of the coronary circulation must be of the greatest service in the maintenance of cardiac compensation. As before, I shall analyse first those cases in which no fibroid disease (fibrous transformation) of the heart-wall was associated with the degenerated state of the coronary arteries.

(a) *Cases without Fibroid Disease (Fibrous Transformation).*

Fatty heart, - - - - -	was noted 16 times.
Atrophy of the heart, - - - - -	„ 5 „
Simple hypertrophy of the left ventricle, „	20 „
General hypertrophy, with dilatation, „	23 „
Aortic valve disease, - - - - -	„ 9 „
Aortic and mitral disease, - - - - -	„ 2 „
Thrombosis of the heart, - - - - -	„ 5 „
Brown atrophy of the heart, - - - - -	„ 4 „
Pericardial adhesion, - - - - -	„ once.
Myomalacia cordis, - - - - -	„ 2 times.
Paleness or softness, - - - - -	„ 11 „
A healthy state of the heart, - - - - -	„ 10 „

From this tabular statement we see that valvular disease pure and simple is not very frequently associated with disease of the coronary arteries. Even the cases in which the aortic curtains were abnormal are not numerous, although disease of these curtains might readily enough extend to the coronary orifices. We see that morbid conditions directly referable to the muscular wall of the heart are of special frequency where the coronary arteries are diseased. Hypertrophy, dilatation, fatty heart, softening, thrombosis, are the conditions of the heart very likely to be associated with coronary disease, a fact not to be wondered at when we reflect upon the serious interference with the healthy nutrition of the heart-wall which must nearly always be present. The cases of simple hypertrophy of the left ventricle were all associated with chronic renal disease, and this may be taken as indicating that the cardiac coronary arteries partake in the general arterial de-

generation which so frequently accompanies chronic Bright's disease. Fatty heart is shown to be a moderately frequent accompaniment of coronary artery disease, and the following table shows the frequency of occurrence of its two forms in these 80 cases:

CASES OF FATTY HEART, ASSOCIATED WITH CORONARY ARTERY DISEASE.

Fatty infiltration ("fatty growth on the heart"),	-	-	-	-	-	12 cases.
Fatty degeneration,	-	-	-	-	-	4 „
Total,	-	-	-	-	-	16 cases.

CONDITION OF THE AORTA.

The following table shows the condition of the aorta in 27 of these 80 cases, in which the coronary arteries were diseased without fibroid disease (fibrous transformation) of the heart-wall:

Atheroma,	-	-	-	-	-	-	23 cases.
Calcareous plates,	-	-	-	-	-	-	3 „
Dilatation,	-	-	-	-	-	-	1 case.
Total,	-	-	-	-	-	-	27 cases.

This means that in 53 of the 80 cases at present under review the aorta was healthy, and it thus follows, that disease of the coronary arteries of the heart may often be quite independent of any affection of the aorta, and cannot be regarded as a mere extension of a morbid process from this vessel.

(b) *With Fibroid Disease (Fibrous Transformation).*

Before tabulating the cardiac conditions observed under this heading, I may observe that fibroid or fibrous transformation of the heart-muscle was more or less extensively present in them all, and that in some of them the state of localized necrotic softening to which the name myomalacia cordis has been given by Ziegler was characteristically present.

I have already at considerable length, and in different communications published my views on the etiology and histology of fibroid heart, and shall at present content myself with this reference to these writings:<sup>1</sup>

Fatty degeneration, - - - -	was noted twice.
Fatty infiltration, - - - -	„ once.
Atrophy, general, - - - -	„ once.
Atrophy, localized to apex, - -	„ once.
Simple hypertrophy of the left ventricle, - - - -	„ 5 times.
General hypertrophy with dilatation -	„ 8 times.
Aortic valve disease, - - -	„ twice.
Thrombosis of the heart, - - -	„ 3 times.
Pericardial adhesion, - - -	„ twice.
Myomalacia cordis, - - - -	„ 5 times.
Rupture of the heart, - - - -	„ once.

The foregoing table is of interest as showing that, in addition to the fibroid disease present in all, general enlargement of the heart, and simple hypertrophy of the left ventricle were frequent conditions. In five of the cases also there was myomalacia cordis which in one had led to rupture of the organ. It is likewise noticeable that here, as in the cases unaccompanied by fibrous transformation of the heart-wall, valvular disease *per se* is not a very frequent occurrence.

#### CONDITION OF THE AORTA.

Atheroma, - - - - -	12 cases.
Calcareous plates, - - - - -	2 „
Total, - - - - -	14 cases.

It is thus shown that when coronary artery disease is associated with fibrous transformation of the heart-wall it is proportionally more frequently associated with atheromatous disease of the aorta.

<sup>1</sup> *Glasgow Medical Journal*, Series 5, Vol. xxii., p. 413, 1884. *The Lancet*, December 10, 17, 24, and 31, 1887. *The Journal of Pathology and Bacteriology*, Vol. ii., No. 2, p. 190, 1893.



CLINICAL PHENOMENA ASSOCIATED WITH DISEASE OF  
THE CORONARY ARTERIES OF THE HEART.

In this part of my investigation I have made a minute study of the clinical summaries supplied to me by the physicians and surgeons at the time I made the post-mortem examinations. These summaries, some of which were full and detailed, are preserved with the pathological reports, and all of them have been carefully read and tabulated with a view to the present paper.

## OCCUPATION.

The occupation was noted in 91 out of the 102 cases in which the coronary arteries were found to be diseased. Of 70 men the occupations were as follows: Labourers, 16; Carters, 4; Engineers, 4; Masons, 3; Seamen, 3; Warehousemen, 3; Brokers, 2; Publicans, 2; Joiners, 2; Shoemakers, 2; Stone-polishers, 2; Miners, 2; Quarrymen, 2; Lamplighters, 2; Potters, 2; Coachman, 1; Gatekeeper, 1; Sawmiller, 1; French-polisher, 1; Boilermaker, 1; Reedmaker, 1; Baker, 1; Colourmaker, 1; Fireman, 1; Debt-collector, 1; Railwayman, 1; Calico-printer, 1; Painter, 1; Clothlapper, 1; Merchant, 1; Cattle-driver, 1; Tramway-guard, 1; Packer, 1; Clerk, 1.

The occupations of 21 women were as follows: Housewives, 13; Mill-girls, 2; Charwomen, 2; Needle-women, 2; Weavers, 2.

From these figures no very definite conclusion can be drawn as to the influence of occupation upon the development of disease of the cardiac coronary arteries. As regards men, however, it might perhaps be fairly enough deduced from the facts before us that those engaged in hard muscular work, or exposed to vicissitudes of weather, or employed at work involving both of these conditions, are on the whole more liable.

SYMPTOMS ASSOCIATED WITH DISEASE OF THE  
CORONARY ARTERIES.

Any classification of the symptoms observed in our 102 cases of disease of the coronary arteries of the heart can, of

necessity, only be of the most general kind. Minute details as to pulse, respiration, etc., can, of course, not be given; but an examination of the clinical summaries may at least enable us to find out how the case was regarded from the clinical point of view, and so far will be of value.

(a) *80 Cases without Fibroid Disease.*

Cardiac and vascular symptoms predominated in	17 cases.
Renal symptoms	15 "
Pulmonary symptoms	12 "
Bronchitis, 5 cases.	
Pneumonia, 6 cases.	
Pleurisy, 1 case.	
Cerebral symptoms	7 "
Symptoms of malignant disease	10 "
Abdominal symptoms	3 "
Surgical symptoms	11 "
Trauma, 5 cases.	
Surgical disease, 6 cases.	
Sudden death occurred in	5 "
Total,	80 cases.

The foregoing tabular statement may be taken as indicating in general terms the diagnosis arrived at during the life of the patient. In the same manner I shall indicate in tabular form the clinical aspect of the twenty-two cases in which distinct fibroid disease of the heart-wall was found to be associated with the affection of the coronary arteries.

(b) *22 Cases with Fibroid Disease.*

Cardiac and vascular symptoms predominated in	7 cases.
"    "    "    with sudden death in	2 "
Renal symptoms	4 "
Pulmonary symptoms (pneumonia),	1 case.
Cerebral symptoms	5 cases.
Surgical symptoms	2 "
Symptoms of malignant disease	1 case.
Total,	22 cases.

The only general conclusion that can be drawn from this tabular statement of predominating symptomatology is that coronary artery disease may be an element to be reckoned with in a large variety of clinical conditions. The figures show, however, that a morbid state of the coronary arteries is most likely to be met with in cases primarily of cardiac or of renal disease. Under the last heading also may be included cases of cerebral haemorrhage, which frequently have their starting-point in renal disorder. The frequency with which disease of the cardiac coronary arteries was met with in patients dying from malignant tumours is also a striking phenomenon, and is in keeping with my experience that in post-mortem examinations of cancerous disease I very often found a wide-spread and often very advanced arterio-sclerosis. These observations seem to me to prove that atheroma of the arteries of the heart may often exist without symptoms directly pointing to the arterial lesion *per se*, so long as a fair general health is maintained. The moment, however, a severe injury, an acute illness, or the development of a malignant tumour takes place, the enfeebled state of the heart induced by the slowly progressive coronary disease makes itself obvious, and may soon give rise to the most alarming signs of cardiac failure.

#### CARDIAC MURMURS IN CORONARY ARTERY DISEASE.

##### (a) *In 80 cases without Fibroid Disease.*

Murmurs of various kinds were recorded as having been present in 16 of the clinical summaries; in 9 of the summaries they were definitely stated to have been absent. We have thus 25 cases in all in which information as to murmurs can be analysed. A ventricular-systolic murmur was noted in 15 cases: in 10 it was limited to the apex region, and in 2 to the basal region; in 2 it was heard over the whole cardiac area; and in 1 it was confined to the tricuspid area. A ventricular-diastolic murmur was only recorded three times; and an auricular-systolic murmur was not noted in any of the summaries. Among the 9 cases in which murmurs were

definitely stated to be absent, 6 presented unequivocal cardiac lesions on post-mortem inspection. Two of these suffered from angina pectoris, and in one death took place suddenly. In 2 of these cases reduplication of the second sound was noted; in 4, tachycardia; in 2, irregular cardiac action; and in 2, muffled sounds.

On further analysing the cases in which murmurs were noted I find that in 9 there was no structural affection of the valves; that in 5 the aortic curtains were diseased; and in 2 the mitral curtains were affected. In one of the two mitral cases the tricuspid was also diseased.

Of the 9 cases in which murmurs were absent only 1 presented a valvular lesion situated in the aortic curtains.

*(b) In 22 cases with Fibroid Disease.*

Murmurs were recorded to have been present in 7, and to have been absent in 2 of the cases. A systolic murmur was noted five times; a combined systolic and diastolic murmur once; and a simple diastolic murmur once. Of the seven cases in which murmurs were noted 4 presented no valvular disease, and 3 did, all of the aortic curtains. In one, however, there was a much dilated aorta, and in one a recent pericarditis. In the two cases without murmur there was no valvular disease.

We have thus in our 102 cases of coronary artery disease 34 in which information as to cardiac murmurs has been preserved. In 11 of these there was no murmur, and in only one of these was there a structural lesion of the valves. In 23 cases murmurs were noted, and of these 10 presented structural disease of the valves, and in 13 the valves were found to be free from structural change.

The numbers are too small to permit of any definite conclusions of a general kind as to the relationships of cardiac murmurs to disease of the coronary arteries. So far as they go, however, they teach us that disease of these vessels may exist without the presence of murmurs; and that where murmurs are present they are not due to organic valve disease in at least half of the cases examined. Under such circumstances



the murmur must owe its origin to these changes in the heart-wall, in the production of which the disease of the coronary arteries must often play an important, if not the only, part.

In the somewhat exhaustive tabulation of the 102 cases of disease of the coronary arteries which was necessary for the purposes of this paper, information as to the duration of the last illness and the mode of death was noted. On scrutinizing the information contained in this portion of the tables I have come to the conclusion that, as regards the arterial disease, a statement of the duration of symptoms is of no special value, as, in many cases of coronary artery disease, there must often be long periods during which no symptoms are complained of. As to the mode of death also, except in those cases to be considered immediately, where the death with fair probability might be attributed chiefly to the morbid state of the arteries, the information is not of special significance for our present enquiry. There are, however, in an enquiry such as this, two matters which do require special attention and investigation, these are the occurrence of sudden death and of angina pectoris in association with disease of the coronary arteries of the heart.

#### SUDDEN DEATH.

In the 102 cases of disease of the coronary arteries sudden death was noted to have taken place 7 times; in the 136 cases where the arteries were healthy it occurred once; 8 times in all. The importance of sudden death in connection with a diseased condition of the coronary arteries of the heart justifies a somewhat detailed summary of the cases in which it took place.

##### *(a) Sudden Death with healthy Coronary Arteries.*

A carter, aged 42. This case has already been given in detail as Case 4 of the series of examples of angina pectoris without arterial disease, recorded at the beginning of this paper.

(b) *Sudden Death with diseased Coronary Arteries, but without Fibroid Disease (Fibrous Transformation).*

(1) A housewife, aged 65. The patient was admitted to one of the surgical wards, suffering from dislocation of the hip, after reduction of which she had shown no symptoms of ill-health. She was found dead in her bed about two hours after she had taken her dinner, at which time she had apparently been in good health. The heart was fatty; there were patches of atheroma in the right coronary artery; and the aortic curtains were atheromatous. There was a patch of myomalacia cordis (acute necrotic softening) in the septal region. The brain presented healthy appearances. The death was obviously due to sudden cardiac failure, and the association of coronary disease with acute softening cannot be overlooked in endeavouring to ascertain the immediate cause of the fatal issue.

(2) A seaman, aged 65. He had been suffering from dyspnoea for sixteen months, and from cough for twelve weeks before admission. He had albuminuria and dropsy. The pulse was 94, and thready. There was evidence of great enlargement of the heart, with apex and sternal V.S. murmurs. He died suddenly after getting out of bed and walking into a side-room. The post-mortem examination revealed interstitial nephritis; great dilatation and hypertrophy of the heart; and extensive disease of the left coronary artery, which was surrounded by a calcareous ring just where it divides into the transverse and descending branches.

(3) A labourer, aged 56. He had suffered from winter cough for four winters, from dyspnoea for five weeks, and from oedema for eight days before admission, after which these symptoms were improving, when he died suddenly. During life there was physical evidence of great enlargement of the heart, but no murmur. On post-mortem examination the heart was found to be enormously enlarged, weighing twenty-nine ounces. The valvular structures were healthy and competent. There was much atheroma of the coronary arteries, with narrowing of the lumen of the right. The aorta was not markedly atheromatous. There was passive hyperaemia of the liver, spleen, and kidneys.

(4) A woman, aged 68, was admitted with fracture of the femur. Although the death was sudden, and the coronary arteries were found to be much diseased, her death was rather to be attributed to an acute, though latent, lobar pneumonia.

(5) A stone-cutter, aged 45. He had been ill for two years with cough and dyspnoea. Latterly there was much oedema, with cyanosis and albuminuria. Death occurred suddenly from cardiac failure. The heart was found to be hypertrophied and dilated, but the valves were normal and competent. There was much atheroma and calcification of the coronary arteries. Silicosis of the lungs was also present.

*(c) Sudden Death with diseased Coronary Arteries and Fibroid Disease (Fibrous Transformation).*

(1) A merchant, aged 45. There was a clinical history of frequent attacks of angina pectoris two years before death, with good health in the interval. Death took place with startling suddenness during the excitement induced by his place of business taking fire. The coronary arteries were found to be narrowed, and there was extensive fibroid disease of the wall of the left ventricle, with considerable fatty infiltration of the external surface of the right ventricle.

(2) A commission agent, aged 51. He had suffered from shortness of breath and palpitation for about three years, and death occurred suddenly during sleep. The cardiac sounds had been noted to be pure, but there was evidence of dilatation of the right side of the heart. At the post-mortem examination atheroma and occlusion of the coronary arteries were discovered, with fibroid disease and recent haemorrhagic myomalacia cordis. Cardiac thrombosis was also present, and the heart weighed  $24\frac{1}{2}$  ounces. In this case there can be little doubt that the sudden death was solely due to the effects upon the heart-wall of the coronary artery disease.

From experimental pathology we know that sudden complete occlusion of a large branch of the coronary arteries stops the heart's action in one or two minutes at the most. The cases which have just been summarized seem to me to prove that disease of these arteries is a very powerful predisposing and

occasionally an exciting cause of sudden death. In 136 cases in which the arteries were healthy and in 75 of which the heart was otherwise seriously diseased sudden death is recorded to have taken place only once. In 102 cases where the cardiac arteries were the seat of disease death took place suddenly in seven. In not one of these cases can the influence of the diseased coronary arteries be excluded in estimating the probable cause of the sudden termination, not even in that one in which acute croupous pneumonia was found. In cases (b) No. 1 and (c) Nos. 1 and 2, we may with very fair probability regard the atheromatous condition of the coronary arteries as the ultimate anatomical basis of the finally sudden demise.

#### CARDIAC PAIN AND ANGINA PECTORIS.

Four cases in which anginous symptoms without disease of the coronary arteries were observed have already been recorded in the opening section of this paper. To these there fall to be added 15 cases in which the coronary arteries were found, on inspection, to be diseased, making a total of 19 cases in the whole series of 238 in which angina pectoris or cardiac pain, more or less severe, was present. The very general belief that an important relationship exists between the development of angina pectoris and the existence of disease in the coronary arteries renders a somewhat careful scrutiny of these cases necessary; and I shall briefly summarize the fifteen, dividing them into two classes, according as fibrous transformation of the heart-wall was absent or present:

##### (a) *Without Fibroid Disease (Fibrous Transformation).*

(1) An engineman, aged 34. In this case chest pain, with tachycardia, irregularity of the cardiac action, and feeble sounds but no murmur, were prominent symptoms. The patient was very stout, and had no albuminuria. The heart was the seat of fatty metamorphosis of both varieties, and was generally dilated. The wall of the left ventricle was thin, and the coronary arteries were atheromatous, though not extremely so.



This was clearly a case in which the primary disease was of the cardiac muscle, and in the production of this the diseased coronary arteries doubtless played a part.

(2) A stone-cutter, aged 64. Suffered from cardiac pain (angina pectoris), palpitation, dyspnoea, and fainting fits. The symptoms had been present for a year. The heart was generally dilated and hypertrophied, and weighed  $21\frac{1}{2}$  ounces. The valves were normal and competent, and, beyond passive hyperaemia, there was no lesion of the viscera. There was moderate atheroma of the coronary arteries and of the aorta. Here also the disease was manifestly cardiac throughout.

(3) A quarryman, aged 54. The symptoms were of five months' duration in all. He had had one or two severe anginous attacks. The other symptoms were dyspnoea, weakness, dependent oedema, and signs of aortic obstruction and regurgitation. There was great hypertrophy of the left ventricle and slight atheroma of the coronary arteries. The cardiac condition was clearly secondary to interstitial nephritis.

(4) A reed-maker, aged 48. Symptoms of chronic bronchitis, with persistent pain between the shoulders. There was slight atheroma of the coronary arteries, with hypertrophy of the left ventricle, secondary to interstitial nephritis.

(5) A lamplighter, aged 39. While in hospital he had repeated daily unmistakable attacks of angina pectoris, in one of which he died. He had suffered from attacks of angina for eleven months before his admission. On inspection, there was found almost complete obstruction of the orifice of the left coronary artery by the encroachment upon it of a thickened patch of atheroma extending from the aorta. There was also a limited pericardial adhesion over the surface of the right ventricle, and brown atrophy of the muscle fibre. With the exception of a slight interstitial nephritis the other organs were healthy. This was very clearly a case of angina pectoris, due to the left coronary artery being obstructed.

(6) An engineer, aged 48. Had suffered from anginal pain for four months, with evidence of chronic renal disease as well. The coronary arteries were atheromatous and tortuous, but the heart was not enlarged, and the valves were normal. There was chronic interstitial nephritis.

(7) A labourer, aged 35. Had suffered from cardiac pain, extending into the upper part of the chest, for eight weeks. There was general dilatation of the heart, which weighed 22 ounces. The descending branch of the left coronary artery was atheromatous. The valves were normal in structure, and, beyond passive hyperaemia of the viscera, no other lesion was discovered. The case was clearly cardiac throughout.

(8) A labourer, aged 46. He had suffered from cardiac pain, lividity, and dyspnoea, for nine weeks, the symptoms being regarded as those of chronic bronchitis. The heart was generally dilated, weighing 17 ounces. The valves were normal in structure, and the orifices only moderately dilated. The left coronary artery was markedly atheromatous. In this case the cardiac lesion was practically the only primary one.

(9) A tailoress, aged 24. The case was one of very characteristic angina pectoris, paroxysmal pain beginning under the left nipple and shooting into the left shoulder and arm, the attacks being associated with paroxysms of dyspnoea. The duration of the symptoms was unknown, and the signs were those of aortic obstruction and regurgitation. Post-mortem examination revealed aortic valve disease, obstruction of the orifice of the right coronary artery, and extensive atheroma of the aorta.

(10) A housewife, aged 46. Rheumatic fever at the age of 19. She suffered from cardiac pain and palpitation for a month before admission. On inspection there was found stenosis of the mitral and tricuspid orifices, with atheroma of the left coronary artery.

*(b) With Fibroid Disease (Fibrous Transformation).*

(1) A clothlapper, aged 66. He had suffered from much precordial pain, with symptoms of Bright's disease, for about three months. The post-mortem examination revealed calcified coronary arteries, with obstructed lumen, especially of the left, and extensive fibroid disease in the areas of distribution of the obstructed vessels. There was also a slight recent adhesive pericarditis, which was not regarded as sufficient to have accounted for all the pain.

(2) This case has already been summarized as (c) No. 1 under the heading of Sudden Death.

(3) A tramway guard, aged 44. Characteristic angina pectoris, beginning in the abdomen, extending to the chest and down the left arm. Attacks of pain had been present for about a year before death. On inspection, cardiac thrombosis, dilated heart, fibrous change in the wall of the left ventricle, and atheroma of the coronary arteries, especially of the left, were found to be present.

(4) A housewife, aged 54. Attacks of pain, beginning in the fingers of the left hand, passing up the arm, and terminating in the precordial region. She had suffered from these attacks for six weeks, but they had only become very severe about ten days before admission. There was a V.S. murmur at the apex, which was displaced downwards and to the left. The autopsy revealed myomalacia cordis, rupture of the left ventricle, many patches of fibrous transformation, and extensive atheroma and calcification of the coronary arteries, with similar changes in the thoracic aorta, the aortic curtains being competent.

(5) A labourer, aged 50. The symptoms were definitely cardiac. He had attacks of pain, beginning at the heart and passing round to the back. Bronchitis had been troublesome for three years, and oedema had set in three months before admission. Both coronary arteries were calcified and narrowed near their origins. There was great dilatation of the heart, with aortic valve disease. Fibrous transformation was well marked near the apex, the wall of the heart in this region being considerably diminished in thickness.

That angina pectoris may frequently occur in patients who have no atheromatous or calcareous disease of their coronary arteries has long been well known, and is abundantly proved by the first four of the 19 summaries given in this paper. It is worthy of note, however, that in two of these four cases fibrous transformation of the heart-wall was present in spite of the healthy condition of the coronary arteries. In one of these two I was of opinion that the fibrous change was of embolic origin, so that here we might have had a disturbance of the intrinsic circulation of the heart without any actual primary disease of the arterial wall. My experience would

lead me to believe that embolism of the coronary arteries as well as atheromatous disease may sometimes be the starting-point of attacks of angina pectoris. From these considerations then it may be concluded that any serious interference, especially if suddenly induced, with the histological integrity of the cardiac fibre is a very frequent cause of angina pectoris.

Turning now to the 15 cases in which the arteries were found to be diseased, I have to point out that in 9 of them typical angina pectoris may be admitted to have been present. In these nine cases the terms "angina pectoris," "angina," "anginal pain," "anginous seizures" were actually used in the clinical reports. The remaining 6 were simply described as having suffered from "cardiac pain," but it may also be allowed in two or three of these, from the description given, that the pain was of anginal character. We may say then that angina pectoris was present in from 10 to 15 per cent. of the 102 cases of disease of the cardiac arteries analysed in this paper. This percentage is perhaps not so great as one would have expected from the ordinary teaching on this subject, but it is large enough to prove that atheroma of the coronary arteries is a very important factor in the causation of this distressing symptom of heart disease. It is also evident that in cases with fibrous transformation of the heart-wall angina pectoris is relatively a more frequent symptom than in cases where this change is not present. Associated with fibrous change, the symptom occurred about once in every 4 cases, without fibrous change about once in every 8 cases, in round numbers.

#### CONCLUSIONS.

From the analysis of the 238 cases dealt with in this paper I may draw the following general conclusions:

(1) Although in many cases, especially of chronic cardiac or renal disease, we may, on careful consideration of all the phenomena, have good grounds for suspecting the presence of atheromatous disease of the coronary arteries, there are no signs or symptoms which can be looked upon as positive or pathognomonic.



(2) Disease of the cardiac coronary arteries is much more commonly met with as one of many co-existent morbid conditions than as an affection *per se*.

(3) On the whole coronary artery disease is not common as an accompaniment or complication of ordinary valvular disease of the heart, and it is more frequently associated with aortic than with mitral valve disease.

(4) The conditions of the heart most frequently associated with or resulting from coronary artery disease are hypertrophy and dilatation, fibrous transformation of the muscular fibre, fatty metamorphosis, acute necrotic softening, localized atrophy of the heart-wall, and thrombosis.

(5) The frequency of the existence in the same case of coronary artery disease and chronic renal disease, seems to indicate that the coronary arteries of the heart participate largely in the tendency to generalized arterial degeneration so commonly met with in chronic Bright's disease.

(6) Atheroma of the coronary arteries, and of the thoracic aorta often co-exist in the same case, but the coronary arteries are frequently found to be extensively diseased when the aorta appears to be quite healthy.

(7) Disease of the coronary arteries of the heart is a frequent factor in the causation of sudden death and of angina pectoris, but on the other hand serious disease of the cardiac arteries is often found to be present post-mortem in cases in which during life no complaint of angina pectoris or cardiac pain had ever been made.

(8) In cases of cardiac pain or angina pectoris associated with disease of the coronary arteries, in which only one of the two arteries is involved, or in which the lesion is more marked in one vessel than in the other, the left coronary is that most frequently affected.

In the laborious work of tabulation for the purposes of this paper I take this opportunity of gratefully acknowledging the valuable assistance I have received from my successive house physicians in the Glasgow Royal Infirmary, Dr. Archibald Young, Dr. William Burns, and Dr. William Martin.

## CASES OF PLASTIC OPERATIONS FOR COVERING BARE SURFACES BY THE DISPLACEMENT AND TRANSPLANTATION OF SKIN FLAPS.

By A. ERNEST MAYLARD, M.B., B.S.LOND.,  
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CASES frequently come before us where, either as the result of traumatism, chronic ulceration or operation, more or less extensive areas of the body surface are laid bare. It is true that in none but the most exceptional instances is nature unable to close in and cover over by cicatrization and the ingrowth of epithelium comparatively large raw surfaces, but the resulting cicatrix and the epithelial covering will be both long and tedious in forming, and often very insecure and inefficient, if not even harmful, when formed. It is therefore to shorten the period of healing, and to cover the bare surface with true skin so as to prevent subsequent distortions, that skin flaps are employed.

There are two methods by which we may cover a surface. We may either displace a flap so that the base or bases of attachment are permanently retained, or we may transplant where the base or bases are subsequently severed, and the flap made to occupy some position more or less remote from its original seat. As illustrations of these two methods, the well-known operations for the formation of a new nose may be instanced. In the Indian operation a flap is *displaced* downwards from the forehead, while in the Italian (Tagliacotian) a flap is *transplanted* from the arm.

Before narrating the cases which I have successfully treated by one or other of these methods, I will indicate a few points which need to be carefully attended to if success is to result.

In the first place every flap should be cleanly cut with a sharp knife, in other words there should be no jaggings or unevenness in the skin and subcutaneous edge. In like manner the flap itself should be detached by as few sweeps as possible of the knife through the subcutaneous tissue, the object being to retain the uninterrupted continuity of the blood-vessels passing into and through the flap. In selecting that part of the flap which is to be the basis of attachment, due regard must be had to the blood supply. Wherever the arteries are largest and most numerous, and are coursing in a certain direction, there we have the guides as to which should constitute the free and which the attached portions of the flap. With the same object of maintaining a free blood supply, care must be taken not to obstruct the vessels either by unduly twisting the base of the flap or by overstretching it. Both these dangers, especially the latter, are avoided by cutting the flap sufficiently large for the area it is required to cover. Again, the blood supply is liable to be obstructed if the dressings are applied too tightly. There should be no more pressure employed than will suffice to keep the under surface of the flap in part or whole gently applied to the raw surface upon which it has been placed.

When a flap is to be transplanted, the free edge should be stitched carefully to the freshened margin of the wound it is intended to cover, so that when the base of the flap is severed the distal part will have become organically connected with the body, and thereby receive sufficient blood supply to nourish the detached portion.

## CASES OF TRANSPLANTATION OF SKIN FLAPS.

### CASE 1.

*Extensive Laceration of Arm: transplantation of skin flap from thorax. Cure.*

H. E., aged fifteen years, was admitted to the Victoria Infirmary on February 14th, 1891, with an extensive lacerated wound of the left arm. The sleeve of his coat was caught

by a revolving pinion wheel, the arm was dragged in and a large area of skin on the posterior and outer aspect of the arm torn off. On March 7th, when the arm presented a healthy granulating surface, a flap was raised from the side of the thorax and attached to the arm; it was somewhat oblong in shape, measuring  $3\frac{1}{2}$  inches in length by  $2\frac{1}{2}$  in breadth. On March 14 the flap was severed from its basal attachment and stitched to the arm. It was noticed at the time of severance that three arteries spouted, showing the good arterial supply to the flap. On March 23rd the report states, "The transplanted flap is living in its entire extent." The part of the lacerated surface above and below the skin flap was successfully grafted. On April 22nd, when the patient left the hospital, the wound was practically healed. (See Fig. 1.)

It will be observed in this case that the flap was cut obliquely from above downwards and forwards, so that the base of attachment was lying in the course of the blood-vessels. The arm was immovably fixed to the side by means of a piece of poroplastic moulded to the shoulder, while the forearm was secured by bandaging. The wound was dressed about three times, and the flap severed from the thorax on the seventh day. The thoracic wound healed rapidly, the extreme laxity of the skin and subcutaneous tissues allowing the skin margins to be easily approximated in the process of cicatrization.



FIG. 1.—Skin flap raised from side of thorax, and secured to margin of ulcer on arm.

## CASE 2.

*Extensive Laceration of the Right Leg: transplantation of skin flap from the left leg. Cure.*

J. B., aged 13 years, was admitted to the Victoria Infirmary on November 28th, 1891. He had been injured by a railway waggon, which, besides bruising his head, had produced an extensive lacerated wound of the right leg, extending from the knee to the malleolus on the anterior and outer side. The



boy had a severe attack of tetanus, from which he recovered and left the infirmary.

On September 8th, 1892, he was readmitted with an extensive ulcer at the seat of the old lacerated wound. It measured about 6 inches in length, and from  $1\frac{1}{2}$  to  $2\frac{1}{4}$  inches in breadth. The edge of the ulcer presented a healing margin,

but the floor, especially towards the centre, was non-vascular and fibrous looking. On September 21st a flap was dissected up from the calf of the left leg, and fixed to the freshened margins of the ulcer on the right. The legs were secured firmly together with a collar of poroplastic. On October 8th the flap was severed from the sound limb. The cut edges of the base bled freely, showing a free vascular supply to the flap. Two days later the flap was looking healthy. On November 12th the ulcer in the back of the left leg, from which the flap was dissected, was healed, it having been grafted. On January 6th, 1893, he was discharged with the ulcer healed. He reported himself ten months later

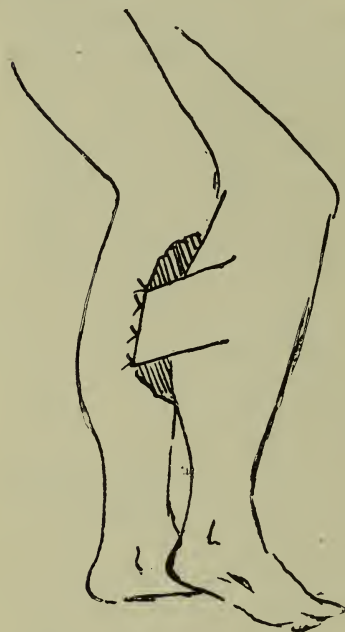


FIG. 2.—Skin flap raised from calf of left leg, and secured to margin of ulcer on right.

in November. The leg was sound, and there was some sensation in the flap. (See Fig. 2.)

The flap in this case was cut from the calf obliquely downwards and outwards, so that the base was above and in the right position for the natural course of the vessels. Owing to the blood supply not being so good in the skin of the legs as compared with the skin of the thorax, I left the severance of the flap from its original position to a later period than in Case I. I believe, however, that, judging from the next case, ten days instead of seventeen would have been quite sufficient.

It was interesting in this case that, when the boy returned to see us about ten months after he left the hospital, there was a limited area of distinct sensation to touch in the transplanted skin flap.

### CASE 3.

*Chronic Ulcer in front of Right Ankle Joint: transplantation of a flap from outer side of left ankle. Cure.*

D. S., aged 23, was admitted to the Victoria Infirmary on 25th May, 1896. He was suffering from a chronic ulcer on the front of the ankle joint of the right foot. Some years previously he had fractured the lower part of the leg. It was put up in splints, and when later these were taken off, he states than an ugly-looking sore existed over the front of the ankle. This he attributed to the pressure of the splints. Since that time several endeavours, both inside and outside hospital, had been made to get the ulcer to heal. It would, however, constantly break down again and cause him continuous trouble.

On admission to the infirmary, an ulcer, somewhat oblong in shape and measuring about 2 inches by 4, was seen over the anterior part of the right ankle joint. It possessed all the characters of a very chronic sore, with little or no indication of any reparative process. On June 12th a plastic operation was performed. The ulcer, comprising its base and indurated edges, was freely cut away, exposing a fresh bleeding surface. A flap of skin, exceeding in area, but similar in shape to the ulcer, was dissected up from the outer side of the left ankle; the base of attachment of this flap was situated about 3 inches above the external malleolus. The legs were then crossed, so that the lower part of the calf of left leg lay on the lower part of the anterior surface of the right. The free edge of this flap was stitched to the distal margin of the ulcer, as also at part of the left edge to the left side of the ulcer. The feet and legs were then fixed in position by previously prepared, nicely fitting poroplastic splints, which embraced the knees above and the feet below. On June 23rd, eleven days after the operation, the base of the flap was detached and stitched to the upper freshened margins of the ulcer. On July 5th the

report states—"the main body of the graft is quite healthy and normal in appearance. Some sloughs are separating from the margin of the graft." On September 1st the patient was dismissed with the parts quite healed. (See Fig. 3.)

This was not such a favourable case to deal with as the former two; and it was only the hopeless condition of the patient's foot that tempted me to run the risk of either making matters better or worse. If the flap sloughed, then by the free excision of the ulcer which the operation entailed, I should have left an ulcer larger than the original; but I knew that in order to give the flap a chance of being vitalized by the tissue around the ulcer, I must excise freely all the cicatricial tissue. I managed to get absolute immobility of the parts by securing the knees in a carefully moulded poroplastic splint, and the toes of both feet by another collar of the same material which slipped on to each foot like a toe cap. The dressings were changed some three or four times, but the splints were not removed till the eleventh day, when the flap was severed from its original attachment. The young man was an



FIG. 3.—Skin flap raised from outer side of left ankle, and secured to margin of ulcer on front of right.

excellent patient who fully grasped the risky nature of the operation, and did his utmost to help us and bear his pains. Unfortunately he did suffer, as we realized after the removal of the splints, for there were two ugly pressure sores, one over the right patella where the left leg had pressed upon it, and one over the external malleolus where the left foot had been supported. These, however, all eventually healed, and the patient left the infirmary well pleased that he was rid of what was a constant source of annoyance and pain to him.

## CASES OF DISPLACEMENT OF SKIN FLAPS.

## CASE 4.

*Hernia Cerebri following the removal of a Tumour of the Brain: displacement backwards, and fixation of a skin flap. Cure.*

J. R., aet. 39, was admitted to the Victoria Infirmary, 17th October, 1893. A large sarcoma was removed from the anterior part of the brain, and a hernia cerebri resulted. To close the somewhat large opening, various mechanical measures were employed, but without avail. In order to check the considerable quantity of brain substance which was being lost, a plastic operation was performed. A flap, having its base below, was dissected up from the anterior part of the scalp, and displaced backwards so as to cover the hernial opening. To relax this flap a second incision was made in front. The flap healed well, and no further protrusion of brain substance took place. (See Fig. 4.)



FIG. 4.—Hernia cerebri cured by displacement backwards of skin flap, and fixation to margins of wound. A relaxation V-shaped flap also displaced backwards and secured.

A full report of the case will be found in the sixth volume of the *Glasgow Pathological and Clinical Society's Transactions*. The loss of brain substance in this case became so alarming, that I decided to try and get the opening closed by a flap of skin. Very little pressure was sufficient to check the protrusion of brain substance, and I thought if this could be effected by a skin flap a permanent cure would result. Fortunately this end was accomplished, and the patient shortly after left the infirmary with the wound quite healed.



## CASE 5.

*Traumatic Necrosis of the Scalp and External Table of the Skull: displacement towards each other, and fixation of two lateral flaps. Cure.*

J. M'A., aged 43 years, was admitted to the Victoria Infirmary on March 4th, 1896. The man, while under the influence of drink, fell with his head into the kitchen fire, where he was found by a neighbour and extricated. A large slough of scalp came away, leaving a bare surface of skull, round in shape, and about three inches in diameter. The wound healed slightly at the margins, but then became stationary,

with the dry brown necrosed external table, the skull showing no signs of separation. In this condition he left the infirmary.

On the 12th August of the same year he was re-admitted with the wound still in much the same condition. A plastic operation was performed. The bare brown external table was chiselled away until a bleeding surface was exposed. Two lateral flaps were detached with their bases below, and brought together over the raw bony surface

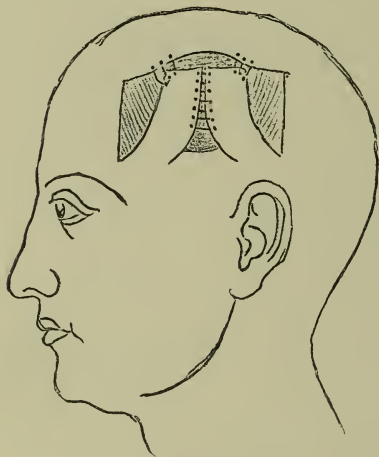


FIG. 5.—Necrosed area of skull covered by the displacement towards each other of two lateral flaps.

where they were united. The wound rapidly healed, and the patient was dismissed cured. (See Fig. 5.)

It seemed somewhat strange in such a vascular region as the skull that, after the lapse of over six months since the date of the injury, there was no appearance of any loosening or separation of the necrosed external table. The skin edges overlapped the dead bone for about an eighth of an inch all round, but seemed to remain in this state without advancing further, or producing any effect upon the parts beneath. In

chiselling away the bone also it was found still intimately connected with the living diploë. It was impossible to get the displaced flaps united over the whole bare surface; they were, however, brought sufficiently close together to leave only a small area uncovered; this, as well as the healthy parts from which the flaps were displaced, very rapidly skinned over.

### CASE 6.

*Chronic Ulcer of the Leg: excision: displacement towards each other, and fixation of two lateral flaps, both left attached at their extremities.*  
*Cure.*

M. W., aged 23 years, was admitted to the Victoria Infirmary on February 15th, 1897. About fifteen months ago patient noticed a small sore on the inner side of the left leg, very itchy and somewhat painful. When first noticed it was about the size of a threepenny piece, but it soon increased in size. In January, 1896, she was admitted into a hospital, where she remained for eight weeks. The ulcer skinned over, but she had not been out of the hospital for more than a week when it again broke down. In October she was readmitted, and remained under treatment for eleven weeks, leaving with the ulcer not quite healed. On admission to the Victoria Infirmary she was suffering from a sluggish, unhealthy-looking ulcer, oval in shape, and situated on the inner side of the left leg above the malleolus. No history of specific disease; no varicose veins. In the course of a few days the ulcer cleaned up, and presented a healthy-looking surface, but in this condition it remained, showing no signs of further advance towards healing.

On 26th February the following plastic operation was performed: By an elliptical incision the ulcer, with some of the surrounding cicatricial tissue, was freely excised. Two incisions were then made, about equal in length to the wound, one in the median line in front, and one in the median line behind. The portions of skin embraced between these two incisions and the original wound were dissected up from the tissues beneath, but left attached at their extremities. Thus

freed, they were drawn together by stitches over the raw surface. A few days later when the wound was looked at, several of the stitches had cut their way through; the flaps had somewhat parted asunder, but seemed fairly secured in their new position. In about three weeks the region of the ulcer was healed; the wounds left by the displaced flaps took somewhat longer. (See Fig. 6.)

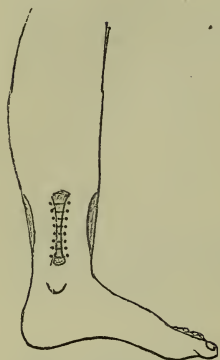


FIG. 6.—Chronic ulcer of leg incised and cured by the displacement of two lateral flaps, both of which were raised but left attached at their extremities.

What the cause of the ulcer was in this case I do not know; it depended, so far as could be ascertained, on no known local or constitutional disturbance. Taking into consideration the age of the woman, and her healthy plethoric appearance, it seemed quite a fair risk to run to freely excise the diseased area, and try to cover it by displaced skin flaps. I was still further tempted to do this, because the skin in the immediate neighbourhood of the ulcer was far from healthy looking, and suggested that should the sore skin over, it would as readily break down again as it had done on two previous occasions.

While this case was under treatment, I observed that Mr. Wallis showed a man at the Clinical Society of London, on February 26th, 1897, upon whom he had performed a precisely similar operation for a large intractable ulcer on the skin. He described it as "A New Method of Treatment of Leg Ulcer." I should think it more than probable that such a common-sense method of treatment has been adopted frequently before either he or I ever performed it or thought of it.

#### CASE 7.

*Complete Traumatic Detachment of the Skin of Scrotum and Penis: displacement and fixation of skin flaps from the thigh and abdomen. Cure.*

J. S., aged 39 years, was admitted to the Victoria Infirmary on November 2nd, 1896. While engaged at work with some other men raising a large iron girder with a crane,

a chain broke. A hook attached to it swung round and entered his perineum. The skin of the scrotum and of the entire body of the penis up to the margin of the prepuce was completely torn off and stripped up to about the middle of Poupart's ligament on the right side, where it remained attached by a pedicle of about  $1\frac{1}{2}$  inches in width. The testicles were completely exposed, and the skin which had been torn from the penis was an intact tube something like

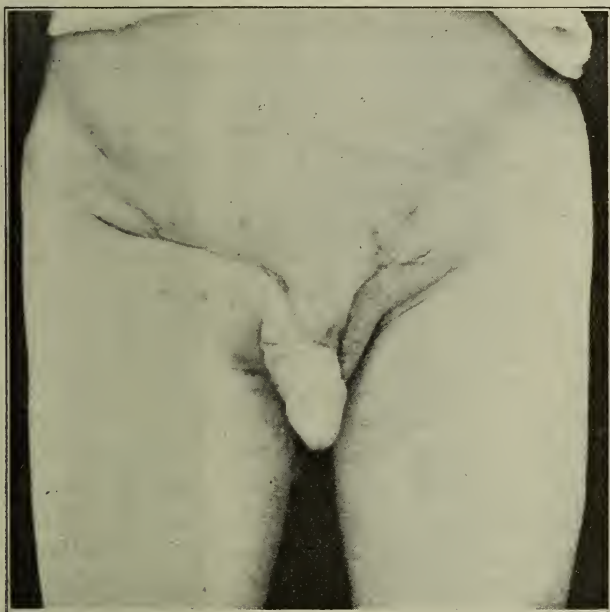


FIG. 7.—Destruction of skin of Penis and Scrotum. Repair by flaps from thigh and abdomen.

the finger of a glove. The parts were carefully cleaned and the skin replaced in position, but in the course of a day or two it showed signs of sloughing, eventually becoming entirely separated.

As soon as the surface had become a healthy granulated one, a plastic operation was performed. Two flaps were dissected upon each side of the wound on the right. The lower one was brought up from the inner side of the thigh, and the upper was brought down from the lower part of the abdomen.



They were united along the dorsum of the penis, and their extremities were stitched to the retroverted prepuce. In order to relax these flaps the bare surfaces left through their displacement were partially closed by stitching together margins of the skin around. The wound ultimately healed, the raw surface becoming completely covered. (See Fig. 7.)

I had only once before seen a case of severe traumatic injury to the scrotum, where a considerable portion of the skin was torn away and the testicles were laid bare. I was, however, greatly impressed by the way in which the skin from the parts around rapidly and completely extended over and covered up the testicles. Had therefore as this case appeared, I still held out the hope that it would be possible to cover both the penis and testes with true skin. What we most feared was the effect of erections upon the displaced flaps. It seemed possible that the irritative effect produced by stitching the distal extremities of the flaps to the margins of the turned back prepuce might be the means of invoking what we most needed to prevent. Large doses of bromide of potassium were given at night, and it is possible that the desired end was reached by these therapeutical measures, for according to the man's statement he was rarely conscious of an erection, and the stitches showed no signs of cutting through the tissues or allowing the flaps to be displaced. The last part to heal was the perineum. The left testicle remained in fairly good position, but the right was drawn up into the inguinal region. This for some weeks was a source of pain and trouble to him; it however lessened until, when he last reported himself, he said he felt perfectly well in every respect.

## SOME REMOTE EFFECTS OF APPENDICITIS.

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THE subject of appendicitis, its pathology and treatment, has for some years occupied so much attention from the profession that the following group of cases, illustrating some of the remote consequences of the affection, may not be without interest.

Whether the original affection of the appendix be catarrhal, ulcerative, or gangrenous, with or without the presence of a foreign body, it is evident that secondary results may follow from extension of the inflammation to the surrounding structures, leading to adhesion of the appendix and caecum, or of the neighbouring viscera—the one to the other. Secondary structural change may ensue from destructive changes in the appendix and adjoining caecum, or from absorption of sepsis or tuberculosis the lymphatic glands may become so enlarged as to give rise to trouble. An interesting feature in the group of cases under consideration is that the primary appendicitis had not in any of them progressed to suppuration, and had, indeed, in several been of such a slight nature as to have been overlooked, till careful cross-examination elicited facts pointing to the nature of the disease.

Naturally the most frequent cause of trouble results from adhesions, which, giving rise to colic on the slightest provocation, may render life a burden, or endanger it by leading to strangulation of a loop of intestine.

The anatomical relations of the appendix are so well known that it is unnecessary to dwell on them, though, as several of

the cases have a special bearing on the position of the omentum, it may be well to bear in mind that, especially in early life, the omentum may extend to the brim of the pelvis, and naturally come in more intimate contact with the then prominent appendix than in later life, when both structures shrink—the omentum being drawn upwards, and the appendix frequently displaced so that it may lie behind the caecum or elsewhere.

Under ten years of age the omentum and appendix, as a rule, seem to be in contact or within reach of adhesion from a mild degree of plastic inflammation. Should such an adhesion take place, the symptoms in the early stage seem to be those of slight gastric disturbance, becoming more severe as the adhesion becomes more intimate, and fibrous contraction of the omentum sets in. The ultimate condition is, that the web-like omentum shrinks and gathers itself into a firm band of tissue extending from the transverse colon to the right iliac fossa. In several of such cases which have come under my observation secondary adhesions have formed between the surface of this contracted omentum and the anterior abdominal wall, especially in the neighbourhood of the umbilicus. Such a band gives rise to great risk of strangulation or to persistent colic, especially marked—as is usual where adhesions implicate the colon—before defaecation occurs. As a rule the pain is described as of a dragging character, and in one case it was noted that during acute spasms the umbilicus was distinctly drawn inwards.

Vomiting, diarrhoea alternating with constipation, frequency of micturition, abdominal distention from accumulation of flatus, may occur at one time or another, and induce such a condition as more than warrants abdominal section.

#### CASE 1.

A. B., a patient of Dr. Gemmell's of Airdrie, came under my care in August, 1892, suffering from acute intestinal obstruction. In 24 hours spontaneous relief was obtained, and he remained well for ten days. He again suffered from acute

obstruction, and as he had a well-marked tumour in the neighbourhood of the ileo-caecal valve, laparotomy was performed at the outer border of the right rectus. A loop of intestine was found, caught between a rigid band, stretching from the right iliac fossa towards the epigastrium and the abdominal wall. This band consisted of a shrunk and rigid omentum, adherent to the appendix and neighbourhood. A large nodular mass was found by the right side of the promontory of the sacrum, evidently consisting of numerous very much enlarged lymphatic glands, which, from their consistence, size, and number affected, were believed to be sarcomatous, and an unfavourable prognosis given accordingly.

The patient recovered well from the operation, the function of the bowel being immediately restored. He was sent home in four weeks with the tumour mass large and easily palpable through his flaccid abdominal wall. We were gratified to learn some months afterwards that the whole of the swelling had disappeared, and that the patient enjoyed perfect health, with no indications of abdominal discomfort. No doubt the glandular enlargement was of a chronic inflammatory nature, due to an old-standing appendicitis, associated with omental adhesions.

## CASE 2.

M. M'L., aged 8, a patient of Dr. Campbell's, with whom and Dr. George Middleton I saw him in August, 1894. He had suffered for two years from occasional abdominal discomfort, and on several occasions sharp attacks of diarrhoea. His acute illness started with diarrhoea and vomiting, followed by violent fixed pain on the right side, with painful defaecation of mucous and watery discharge. Tympanites and elevation of temperature to 101 degrees followed, and the boy's condition, while not alarming, showed no signs of improvement. After waiting a few days, as the pain and tenderness in the right iliac region persisted, though there was no evidence of abscess, it was deemed well to open the abdomen. An incision along the outer border of the rectus revealed a firm band of tissue stretching from the neighbourhood of the umbilicus to the right



iliac fossa. This tissue, composed of altered omentum, was remarkably firm and rigid, with a number of minor adhesions to the surrounding intestines. The band was divided and as much of it removed as possible.

The patient made an interruptedly good recovery, all symptoms of abdominal discomfort rapidly disappearing. He has since remained well, with the exception of an occasional attack of diarrhoea.

### CASE 3.

G. H., a professional brother, was seen, in consultation with Dr. Samson Gemmell, in the country in April, 1894. At several periods within eighteen months there had been attacks of abdominal pain, generally lasting an hour or two. In November of 1893, however, an extremely acute attack of pain occurred, necessitating rest in bed for three days. The pain was not localized, and was not attended with rise of temperature nor abdominal distension. The acute pain lasted eight hours, and after two days in bed the patient felt so well that he left his bed only to return to it in a few hours with another severe attack of pain, attended with vomiting and hiccup. There was now some rigidity of the abdominal muscles on the right side and a tender swelling in the neighbourhood of the appendix. From this time onwards there were constantly recurring attacks of pain at intervals of a few days, and at one time only as long as three weeks.

When seen the patient was very pale and thin. The only physical sign was a distinct thickening in the region of the appendix. This swelling was ill-defined in outline, and not painful on pressure. There was no abdominal distension. In view of the persistent abdominal trouble it was decided to open the abdomen, for which purpose the patient was removed to a nursing home in Glasgow.

On opening the abdomen along the outer border of the right rectus muscle the caecum, ileum, and bladder were found firmly united by a dense cicatricial mass, to which the omentum was adherent.

After liberating the omentum the middle band of the caecum

was sought for and used as a guide to the appendix, which was found, on splitting up the cicatricial tissue with knife and scissors, lying in it like a worm in its burrow. The terminal part of the appendix was converted into a fibrous band, and seemed fixed to the brim of the pelvis. The appendix thus cicatricially contracted no doubt acted as a check on the movements of the caecum, and gave rise to the violent and recurrent colics.

The appendix was removed and the patient made an excellent recovery, with the exception that he suffered from a somewhat extensive and very troublesome neuritis in the arm and leg, coming on a fortnight after the operation. Since the operation till now there has never been the least trouble or inconvenience of any kind with the bowels.

#### CASE 4.

C. S., aged 13. Was seen in consultation with Dr. Whiteford, of Greenock. He was a delicate lad, who had suffered from obscure abdominal trouble for some years. In January this year he suffered from very marked abdominal pains, like colic, apparently due to obstruction of the bowels. No relief was obtained by the use of a laxative or enemata. In a few days the temperature rose to  $101^{\circ}$ , and tenderness was found in the right iliac fossa over a swelling which was not unlike a scybalous mass. I saw him twelve days after the onset of the symptoms, which had not greatly increased in intensity during that time. His pulse, however, was rapid, 130; temperature,  $100^{\circ}$ ; tongue coated; breath with disagreeable earthy odour. He did not seem to suffer acutely, and had very little vomiting. The abdomen was distended, and in the right iliac fossa a nodular tender mass could be felt, apparently about 3 inches in diameter. This mass was not adherent to the abdominal wall, and had bowel in front of part of it. With the local guide laparotomy was recommended and performed over the appendix. On dividing the abdominal wall in the line of the fibres of the external oblique, the omentum was found stretching tightly over the nodular tumour mass

which lay behind the terminal part of the ileum, and consisted of a mass of chronically inflamed lymphatic glands. The omentum was firmly fixed into the right iliac fossa and thence radiated to the transverse colon. It was abundantly evident that the ileum was firmly compressed between the mass of glands, which equalled in size a man's fist, and the tense and hardened omentum. The omentum was divided between a series of ligatures. The appendix was evidently embedded in the cicatricial tissue at the seat of the omental adhesion, and as the boy's condition was very bad it was not deemed advisable to disturb parts in attempting to remove it, more especially as there was no evidence of active local mischief.

After operation he rallied fairly well, and some flatus and faeces escaped from the bowels. Next day, however, he vomited some blood, and on attempting to raise himself in bed suddenly died.

#### CASE 5.

D. T., aged 7 years. Had suffered for  $3\frac{1}{2}$  years from recurrent colic, and was seen in consultation with Dr. Smith, of Lenzie. The patient, a delicate-looking girl, had rarely been free from severe abdominal pains, only once had such an interval as three weeks elapsed. At times vomiting had occurred, and in the earlier days some bladder irritation, so that the case was looked on as a case of distension of the bladder. An area of dulness formed under the umbilicus, through which pus discharged for a time. No relief, however, followed though all sorts of sedative and carminative medicines were administered. The mother was quite decided that at the beginning of the illness pain and tenderness were most marked to the right of the umbilicus.

When seen the abdomen was not distended, indeed there was nothing apparently wrong. On palpation, however, it was evident that the abdominal wall was more rigid on the right side than on the left of the umbilicus. During a spasm of pain it was observed that the umbilicus was indrawn. The colic was ever most troublesome previous to defaecation.

On 20th December, 1897, assisted by Drs. Russell and

J. B. Anderson, the abdomen was opened and the omentum found attached to the neighbourhood of, but not directly to, the appendix, also very firmly adherent to the umbilicus. The omental tissue was firmly fibrous in structure. The adhesions to the umbilicus could only be freed by division, which was done between ligatures, the greater part of the omentum being thus removed.

The child has since made excellent progress. Temperature normal, and the pain quite gone.

While the importance of adhesions as a cause of abdominal pain and colic is well recognized, it is of no less importance to determine as far as possible what are the probable causes of such adhesions, and in the absence of tubercular disease, tumours, or of pelvic inflammations in connection with the female generative organs, it seems not improbable that the great proportion of peritoneal adhesions will be found associated with old-standing appendicitis.

The glandular enlargements are further of much interest. In acute cases of appendicitis, no doubt, the lymphatic glands are implicated, but, as elsewhere in the body, the local inflammation and its consequences masks the glandular inflammation. In subacute forms of appendicitis, however, as for example in the chronic ulcerative type, such glandular enlargement may assume considerable importance, and may even be readily mistaken for malignant tumour at the ileo-caecal valve or neighbourhood. Especially is this the case when partial obstruction takes place from pressure on the ileum by the projecting mass of glands.



## TWO CASES OF PAPILLOMA OF RECTUM TREATED BY EXCISION OF MUCOUS MEMBRANE.

BY T. KENNEDY DALZIEL, M.B., C.M., F.F.P.S.,  
Assistant Surgeon, Western Infirmary; Surgeon, Royal Hospital for Sick Children.

THE following case seems worthy of being put on record, not only on account of the rarity of the pathological condition, but also as illustrating a method of treatment which has been entirely successful in relieving much suffering and saving life. I have avoided publishing the case earlier that time might test the efficacy of the treatment.

### *CASE 1.*

The patient, A. W., aged 57, was sent to me from the country by Dr. Jackson, of Sanquhar, suffering from rectal haemorrhage occurring at and after each stool, with, in the interval, a considerable watery discharge. Occasionally considerable prolapse of the rectum occurred, necessitating manipulation for its reduction, and this was even attended by somewhat serious haemorrhage. There was constant difficulty in securing satisfactory evacuation of the bowels. The patient was markedly anaemic, looking and feeling very ill. On examination, the interior of the rectum was found to be lined with soft velvety papillomata, occupying the entire membrane in the lower 5-6 inches of the bowel. The anal portion of the gut was free. The upper margin could be reached on one side when prolapse of the lower zone had been induced.

In the nursing home on the 10th May, 1895, I removed the diseased mucous membrane.

An incision was made from the bulb of the urethra to the coccyx, and the anus, with the surrounding structures, divided in the middle line, the anal portion of the bowel being thus split; then the two sides were drawn apart and the mucous membrane divided circularly about  $1\frac{1}{4}$  inch from the anus, and the papillomatous mucous membrane separated from below upwards, leaving the muscular coats exposed for a distance of at least six inches. The tendency to prolapse doubtless rendered this easier than was to be expected. Bleeding was arrested by ligation during the progress of the operation, and though a considerable loss of blood took place, it did so rather from injury to the extremely vascular papillomata than from the wound. Having reached the upper margin of the disease, the mucous membrane was again circularly divided about  $\frac{3}{4}$  inch above it. The cut edges of the mucous membrane were then approximated, and in doing so the muscular coats of the bowel were reduplicated and fixed with numerous buried sutures, so that on suturing the mucous membrane there was little tension on the stitches.

The antero-posterior incision in the anal gut, with its sphincters, and in the perineum, were accurately sutured, and an antiseptic dressing introduced into the bowel and applied externally. The parts were not disturbed till the third day, when numerous large hard scybalous masses began to come away, threatening to interfere with the healing process, and indeed a few stitches gave way at one side, not attended, however, with any troublesome after-consequences. These scybalous masses were evidently not of recent origin and were broken up with difficulty. The bowels had been freely moved previous to the operation.

The temperature remained normal. Healing was complete in sixteen days, and the stitches removed. The subsequent history, in the words of the patient himself, is that, "On returning home I weighed nine stones, and am now over twelve. Have had no trouble with my bowels, which act regularly without pain or difficulty. My general health is excellent."

Recent examination revealed no evidence of recurrence of the disease, and no stricture of the rectum.

### CASE 2.

A female child was admitted to my ward in the Children's Hospital on 8th April, 1896, suffering from haemorrhage from the bowel, with slight prolapse and occasionally difficulty in defaecation. No very accurate history could be obtained as to duration of the condition. On examination it was very evident that the mucous membrane was studded with numerous filiform papillomata, occupying the entire tissue of the bowel, and bleeding readily on handling. Under chloroform only slight prolapse of the mucous membrane could be induced, and the papillomatous condition was present as far as the finger could reach. In view of the persistent loss of blood, immediate operation was recommended, and the mucous membrane removed in the same manner as described in the preceding case.

With the smaller working space in the child it was a matter of much greater difficulty to remove the mucous membrane. With the free use of the ligature, however, comparatively little blood was lost, and  $2\frac{3}{4}$  inches of the mucous membrane were removed, and the stitching carried out as in the previous case. The mucous membrane higher up seemed to be affected with a number of papillomata, but it was not deemed possible to remove more and secure coaptation of the cut margins. The rectum was irrigated and lightly packed with iodoform gauze. The patient made a rapid recovery, though for some weeks she suffered from incontinence of faeces. Now she has perfect control of the bowel and no difficulty in defaecation. Nor is there, as far as can be determined, any disease, as was feared, above the seat of operation.

*Note.*—The patient remained well for about a year when she commenced to suffer from symptoms of obstruction and occasional haemorrhage from the bowel. She again came into my care in the Children's Hospital when we performed left inguinal colotomy. Through the wound came two months later an intussusception of the whole of the large intestine, reduced by laparotomy after removal of very numerous

papillomas (pedunculated adenomata), from the exposed surface. The bowel was found to be thickly studded with the growths from the rectum to about eight inches above the ileo-caecal valve. The patient recovered well from the operation, but has still the colotomy opening and the growth in her bowels.

In these cases I was encouraged to remove the mucous membrane only by the belief that the disease was simple in nature and limited to that structure, that the mucous membrane, especially in the adult, was freely movable on the muscular coat, which in turn was distended and lax, readily permitting downward traction of the bowel.

It is probable that equally satisfactory results might have been obtained by removal of the whole wall of the rectum, but the modified proceeding as adopted seemed to me a less serious operation, especially attended with less risk in the event of suppuration occurring.



The free median incision through the anus and division of the mucous membrane above the sphincters affords ample room for working. In several cases of cancer of rectum not involving the sphincter I have been enabled to remove from 3 to 4



inches of the rectum with subsequent complete restoration of the action of the sphincter. The photograph on previous page illustrates the pathological condition found in Case 1. The specimen now measures 5 inches in length. The photograph was taken in the pathological department of the Western Infirmary. Microscopically it was found to be a villous papilloma.

# TURBINECTOMY FOR THE RELIEF OF NASAL OBSTRUCTION AND ASTHMA.

By WALKER DOWNIE, M.B., F.F.P.S.,

Lecturer on Diseases of the Throat and Nose, Glasgow University.

IN the report of the Western Infirmary for the year ending October, 1896, sixty-four turbinectomies are recorded as having been performed in the department under my care. These were performed on twenty-seven individuals, who suffered from nasal obstruction due to abnormalities of the turbinal bodies, and the separate operations were carried out at intervals as will be explained when the operation is being described. Cases of nasal blockage caused by deflections, deformities and out-growths of the septum are excluded, as are also those due to post-nasal growths and causes other than those specified.

Much has been written during the past few years on the subject of turbinal hypertrophies and their treatment, in which much diversity of opinion has been expressed, but here I will confine my remarks to the cases treated during the twelve months noted in the above report, referring in those remarks particularly to the complaint made by those who sought relief, to the conditions seen on examination, to the operative treatment pursued and the results, comparing the latter with those following operative methods advocated by others.

## COMPLAINT.

The cases may be roughly divided, according to the complaint made by the patient, into three sets.

*First Set.*—Twelve patients complained of variable nasal

obstruction, sometimes one side being blocked, sometimes the other, rarely were both nares affected at the one time. The intra-nasal swelling causing obstruction, and which was frequently accompanied by sneezing and increased secretion, was excited by various means, amongst them being change of posture from the upright to the prone position, sudden alteration in the temperature of the air inspired such as experienced in going from a warm room to a cold one, coming from the outer air into a heated room, excessive moisture in the air, walking against a high wind, inhalation of air impregnated with dust, particular odours, etc.

*Second Set.*—In ten cases the complaint was that of more or less constant nasal obstruction. Nasal respiration in many of the cases was reduced to the vanishing point, the voice lacked resonance, nasal secretion passed in quantity into the throat: in some hearing had become seriously impaired, in others tinnitus was constantly present, and, in almost all, the patients had persistently those symptoms which are usually considered indicative of a cold in the head. In three of those cases the turbinal hypertrophy was associated with the presence of nasal mucus polypi, and in these turbinectomy was performed to permit of the complete extirpation of the polypi.

*Third Set.*—In five cases the distress complained of was asthmatic in nature. The asthma was in most of the cases of sudden onset, and the exciting cause varied even in the same individual. It might follow the inhalation of dust as in sweeping a room or in sweeping the ward as in the case of a nurse, the inhalation of fine powder during its trituration as described by a patient who is a chemist, the smell of a farm particularly the stables or wherever hay was lying about, and excitement in some cases; while in others the onset would occur during sleep and without apparent cause. The first symptom in all of those cases was sudden intra-nasal fulness, followed by violent sneezing and excessive watery discharge, and then a gradually increasing sense of tightness across the chest, followed more or less rapidly by the well-known asthmatic distress. In the remaining two sneezing was exceptional.

## THE TURBINALS.

There are three turbinated or spongy bones (for brevity termed turbinals) in each nostril. The superior and middle ones are portions of the ethmoid, while the inferior one is a separate bone articulating with the superior maxilla. These different turbinals, springing from the outer wall, curve inwards and downwards towards the middle line, dividing each nostril into three meatuses, and presenting in the normal nose an extensive surface by which inspired air is warmed and moistened on its way to the lungs. Broadly it may be said that the superior and middle turbinal bones are covered with highly vascular mucous membrane continuous with that of the pharynx, along with a submucous tissue firmly incorporated with the periosteum, and rich in secreting glands. The inferior turbinal bone has a similar covering, but here the venous plexuses are particularly abundant, the structural arrangement being somewhat similar to that of the erectile tissue in the genital organs. The fibrous trabeculae support in their meshes a network of venous channels lined by endothelium, and in the main those vascular channels are surrounded by muscular fibres arranged in circular and longitudinal layers. The presence of the erectile tissue is specially for defensive purposes—air charged with deleterious particles or vapours usually acts as the excitant, the resulting fulness of the vascular tissue narrows the nares and increases the moisture of the surface—so that foreign bodies in the inspired air are attracted to the moist surface and there made captive. When the air is pure no such protection is called for, and the turbinal body, if healthy, should become collapsed, leaving the passages of the nares free. When, however, the tissue is hypertrophied, there is a permanent interference with nasal respiration; and if, in addition to permanent increase in size, there is an undue sensitiveness of the tissue implicated, then in many cases its removal becomes necessary to permit of normal respiration as well as for other reasons.

## CONDITIONS FOUND ON EXAMINATION.

In the first set of cases—occasional obstruction varying in degree—the erectile tissue distributed over the anterior end



of the inferior turbinal was chiefly at fault, though in most cases there was hypertrophy of the anterior portion of that bone as well. Much comfort can be given to such patients by the application of those therapeutic agents which cause contraction of the vessels such as cocaine, menthol, and camphor, but such applications will never give permanent relief. To attain this end nothing short of removal of the hypertrophied hypersensitive tissue will suffice.

In the second set of cases—serious blockage more or less constant—there was for the most part hypertrophy of the bone (inferior turbinal) throughout its length, associated with considerable swelling of the covering mucosa. In these cases it is interesting to observe the appearance of the posterior portion of the inferior turbinal. Normally the surface of the anterior third, or even the anterior half, is smooth, and the posterior half is somewhat wrinkled; but in the abnormal structure, while the anterior portion remains smooth, even while greatly increased in size, the surface of the posterior half is markedly roughened, resembling the convolutions on the surface of the brain in miniature in many cases, while in others the posterior end looks like a raspberry. (These characteristics will be found illustrated in Plate I., where the smooth anterior portions are shown on the right, while to the left are rough posterior portions which have been excised.) This roughness of the surface is due to atrophic and oedematous changes in the muscular walls of the blood sinuses, permitting of great distension of their walls. The obstructing swelling thus, as far as the soft tissues are concerned, is the result of dilatation, or a varicose condition of the venous channels, along with a general oedema of the mucosa.

In the third set of cases—where asthma is secondary to some intra-nasal irritation—the conditions are much more complex. There is no constant nasal deformity or lesion, except it be hypertrophy of the posterior ends of the inferior turbinals, where the vascular mucosa was in each case markedly roughened and oedematous. On the other hand, a condition similar in all respects, as far as the eye could judge, was present in most of those cases included in the second set, without any reflex symptom being excited. One case in the

third set had, in addition, several mucous polypi in the superior and middle meatuses; and in two cases there was great enlargement of the anterior ends of the middle turbinals.



PLATE I.—ANTERIOR AND POSTERIOR PORTIONS OF HYPERTROPHIED INFERIOR TURBINALS EXCISED. Smooth anterior ends are shown in column to the right; posterior portions illustrating brain-like surfaces when hypertrophied in column on the left.

## OPERATIVE MEASURES ADOPTED.

The operation of turbinectomy may be practised in the inferior or middle turbinal, and it may be partial or complete. The following terms are thus called for to indicate what parts have been removed: *anterior inferior turbinectomy*, when the anterior portion of the inferior turbinal has been excised; *posterior inferior turbinectomy*, when the posterior portion has been similarly dealt with; *total inferior turbinectomy*, when the whole of that bone has been removed.

In the first set of cases anterior inferior turbinectomy was performed, the soft structures being removed by means of cautery and snare, and the bony portion by scissors, after the pattern of elbow scissors. The results from the use of chemical caustics and galvano-puncture, recommended by some, are most unsatisfactory when compared with the relief following the measures here adopted, measures which might by some be considered somewhat severe.

In the second set, the removal of bone is absolutely necessary—it may be anterior turbinectomy alone that is called for or posterior turbinectomy alone, or both on the same side, which is the operation I advocate in such cases, or the whole inferior turbinal may be removed as first extensively practised by Dr. Carmalt Jones. The anterior end of the bone is removed with scissors as just described, and the posterior end by means of Jones' spokeshave (or turbinotome), or by means of a steel wire snare. Whatever instrument is chosen the bone should be cut obliquely, so that when the anterior and posterior ends have been removed a tongue-shaped central portion of the bone remains projecting from the outer wall. The importance of this, as bearing on the subsequent comfort of the patient, cannot be over-estimated.

In one-third of the cases of severe blockage anterior middle turbinectomy was also performed, and some of the portions removed are shown in Plate II. As will be seen, those portions of bone are in many instances hollowed out, the air spaces being abnormally developed apparently, and the resulting osseous cysts contained in most cases air (pneumatic cysts), one contained serous, and another, purulent fluid.

In the third set of cases—those with asthma—the abnormalities, as already stated, varied. In each case the affected

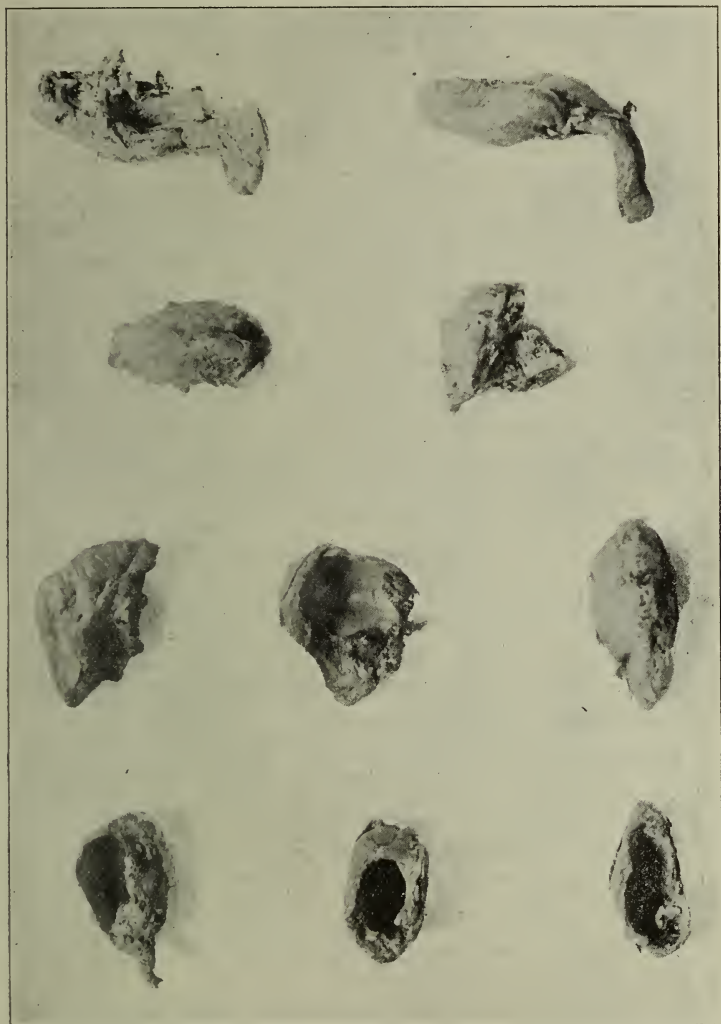


PLATE II.—ANTERIOR PORTIONS OF MIDDLE TURBINALS EXCISED. The two upper ones illustrate oedema of the mucosa accompanying hypertrophy of bone; the remaining eight illustrate cystic conditions, some intact, others cut across, referred to in text.

tissues, hypertrophic, oedematous or polypoid, were carefully and completely removed by means of the galvano-cautery



scissors, snare, and turbinotome, according to the size and position of the part at fault. Anterior middle turbinectomy was called for in two of the cases, and in each of them the enlarged end formed a bony cyst containing thick syrup-like fluid.

#### RESULTS.

The patients included in the first set of cases were completely relieved of their discomfort by the means described.

Those under the second category were also in every instance enabled by the operation to breathe through the nose as they had never done before; and this great relief to the breathing was in no instance followed by a dry pharyngitis which so frequently appears some time after total or complete inferior turbinectomy. Some weeks after this latter operation has been performed, in a large proportion of cases the patient begins to complain of dryness in the throat. Secretion rapidly arises on the surface of the pharynx, from which it is dislodged and hawked up with difficulty, and later the larynx tends to become similarly affected. This pharyngeal complication is due to the unnaturally wide bore of the nares after such an operation, the middle and inferior meatuses being, after the complete removal of the inferior turbinal, virtually one straight air-channel, deprived of the means to warm and moisten the air on its way to the pharynx. I remarked on the importance of leaving a central tongue-shaped portion of this bone, describing the method by which it may be accomplished; and if this method is adopted, the two lower meatuses remain as separate passages, and the central portion so distributes the inspired air that it not only becomes warm and moist, but it enters the pharynx in a more natural way, and less as a direct current, striking certain parts with undue force affecting them prejudicially. By the method recommended dry pharynx as a sequela may be prevented.

One cannot yet say that intranasal lesions predispose to spasmodic asthma, but the fact remains that many cases of asthma are dependent on some intranasal peculiarities, and it is also a fact that many of those cases are amenable to treatment involving the removal of hypertrophied oedematous vascular tissue, hypertrophied bone, and mucous polypi.

Of the five cases operated upon three were cured and the remaining two were greatly relieved.

One case, that of a hospital nurse, may be quoted as illustrating the satisfactory results of such treatment. She was subject to frequent attacks of cold in the head, which occasionally ended in bronchitis; dust in the air produced paroxysms of violent prolonged sneezing, as did also the smell of hay, and the attacks excited by the latter invariably terminated in severe asthma. Her home is at a farm, and the holiday visits to her parents were regularly in great part spent in bed. In the summer of 1895 she went home, and on the second day took asthma which kept her in bed for close on three weeks. Anterior and posterior inferior turbinectomy were performed on each side—first part in June 1896, and second operation in October, that is four months later. Since the latter date she has rarely had a nasal catarrh, and she spent nearly four weeks at her father's farm in July last (1897), going out and about freely without having either sneezing or asthma, both of which she has had as regularly as she returned home each summer during the past eight years.<sup>1</sup>

<sup>1</sup> After the above was put in type (September, 1898), this patient informed me that, since the foregoing report was made, she has had neither coryza nor threatening of asthma, and that notwithstanding the spending of four weeks in the country during the hay-harvest time.

# THE APPLICATION OF THE RÖNTGEN RAYS IN THE MEDICAL AND SURGICAL DEPARTMENTS OF THE ROYAL INFIRMARY, GLASGOW.

By JOHN MACINTYRE, M.B., C.M., F.R.S.E., F.R.M.S.

## INTRODUCTION.

THE experiments recorded in the following pages were begun towards the end of January, 1896, within seven weeks of the publication of Professor Röntgen's classical paper, which was read before the Würzburg Physical Society on November 24th, 1895. The results were sufficiently promising to induce me to request the managers of the Royal Infirmary to form a new branch of the electrical department of the hospital. This proposal was carried into effect towards the end of February of the same year, and Drs. Archibald Faulds and George M'Intyre were appointed assistants in the electrical department, the latter to devote himself more particularly to the medical cases, the former to look after the surgical. Since then these gentlemen have rendered great assistance to members of the staff in their respective spheres, not only in connection with the X rays, but generally in the medical and surgical electrical appliances of the hospital, and I have much pleasure in tendering my thanks to them for the time spent and labour expended in the performance of their duties.

Any one who took the trouble of reading Professor Röntgen's original work, could not fail to appreciate the value of direct inspection of the tissues of the body, as revealed by the fluorescent screen. It need hardly be pointed out, however,

that the photographic aspect of the question was first of all seized upon and practically to the exclusion of the other. As the art progressed, however, it became more and more apparent that while photography might be useful by way of permanent records, direct vision would in all probability become the more important of the two. Viewed from the knowledge of the present day, considering that Professor Röntgen's great discovery was first made by what he *saw* upon the fluorescent screen, and that photography was a secondary detail, it is somewhat interesting to look back upon the claims for advances and discoveries put forward by many within a short period of the publication of the original paper. This remark is made, firstly, because the experimental work in the Royal Infirmary has convinced me of the great value to be attached to the whole of Professor Röntgen's original work; and, secondly, because I desire it to be clearly understood that the entire credit of observation by direct vision and photography is due to Professor Röntgen, and to him alone. All that the original discoverer left for any one else to do was improvement in apparatus and practical application.

While this much may be said, it is only fair to state that for many reasons the photographic art was the first and the more easily developed. Step by step with the advancement of the photographic art, improvements were however made in fluorescent screens, and if this method has developed more slowly than the other, its value is steadily increasing.

#### APPARATUS.

Speaking generally, it may be said that the supply of electricity from the mains gives the most satisfactory results. In the Glasgow Royal Infirmary the installation includes gas engine, dynamo, and secondary cells, and the whole house is wired for a fifty volt system. Where heavy currents are required, say for the cautery, much heavier leads are taken to the instrument; and in the case of X ray work, as presently used, twenty to twenty-

Source of the  
Current.



five amperes may be required for the coil. Primary batteries we have discarded altogether. It has to be admitted, however, as we found by experiment, that currents from large

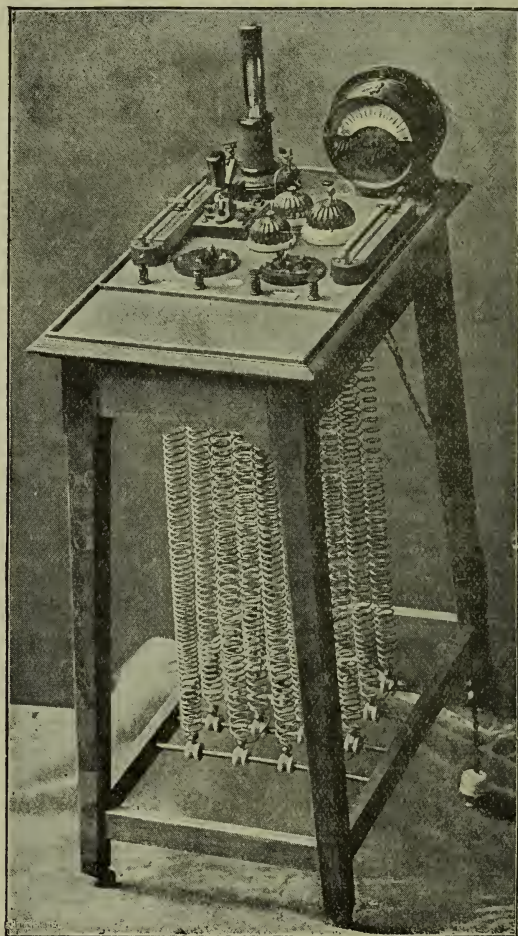


FIG. 1.—PORTABLE STAND FOR RHEOSTAT METERS USED IN X RAY WORK.

secondary cells, such as we use for surgical electrical purposes, are apt to cause severe sparking across the platinum points of the interrupter, with the result, as it is hardly necessary to point out, that there is a considerable decrease in the working

efficiency of the coil. Under these circumstances, Drs. Faulds and George M'Intyre have frequently used smaller secondary cells charged from the dynamo, and made by the Litanode Company, London.

The above-mentioned difficulty may be overcome in more ways than one, but the most common is the employment of rheostats properly arranged. Figure 1 shows a portable rheostat designed by the writer, and employed in the hospital for such work. It consists essentially of a portable table below which, by means of proper platinoid wires attached to various studs, resistance may be thrown in as desired. On the same table an ampere meter and a galvanometer may be placed, so that exact measurements for the particular coil may be estimated. There is one drawback, however, to this resistance, that while we are able to vary the amperes of current the voltage is not taken into account.

At my request, therefore, Mr. Schall, of London, has constructed another rheostat as seen in Figure 2. By means of this new arrangement not only can we vary the number of amperes, but the number of volts can also be controlled by the operator.

The principle of this rheostat may be briefly described in the following way: The current from the mains passes directly through a stout platinoid wire as soon as the switch on the rheostat is turned on, the resistance being 4 ohms, and the diameter of the platinoid wire sufficient to allow of 25 amperes to pass without getting hot. The current which is to pass through the primary of the spark coil is obtained by tapping the above-mentioned platinoid wire at suitable places to obtain the desired voltage. If we take the two ends of a line and mark them *A* and *B*, and another point in that line and call it *C*, then if we tap it at two places, say *A* and *C*, the

#### Rheostats.

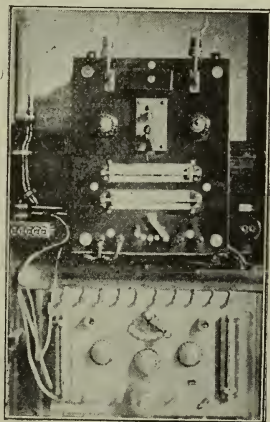


FIG. 2.—X RAY RHEOSTAT FOR VARYING VOLTS AND AMPERES.

electromotive force of the shunt circuit depends upon the difference of the resistance between  $AC$  and  $AB$ ; making  $C$  variable, we can vary the electromotive force of the shunt circuit to suit the special purpose. If the coil be connected to  $A$  and  $C$  there are two ways open to the current, one through the platinoid wires of the rheostat, and the other through the thick primary wire of the coil. The current will divide itself between these two loops in proportion to the resistance it finds on the way. To facilitate a perfect control, a small rheostat with a variable resistance is inserted in this shunt circuit, so that the proportion can be conveniently varied. In my rheostat the current in the shunt circuit may be varied between 5 amperes and 25 amperes. When the interrupter begins to vibrate, the current is shunted; while the interrupter makes contact, it passes through the primary of the spark coil; while it breaks the contact, it passes through the platinoid wires of the rheostat. The current from the main is never broken, it is only being shunted in other channels, the consequence being that the sparks at the platinum points of the interrupter (which are so strong under ordinary circumstances that the platinum has to be renewed fairly frequently) are scarcely perceptible with this shunt arrangement.

The advantages of this rheostat are very great, because we can arrange the number of volts and the number of amperes for any size of coil from the two to the eighteen inches spark. My work has not only been greatly facilitated by means of this new arrangement, but sparking across the platinum points of the contact breaker has been diminished, and the risks to the Crookes' tubes have been considerably lessened, while the steadiness and constancy of current have been assured—matters of great importance, as any fall in either ampereage or voltage as indicated on the meters can be instantly corrected by the operator.

The most of the experimental work in this hospital has been done by means of one of Apps-Newton coils of ten inches spark, and within certain limits this may be considered an excellent instrument. I have had many opportunities of testing coils from two to eighteen inches spark of the Apps-Newton pattern, and in no

**Transfor-  
mers, etc.**

case have I found one which did not fulfil all that was expected of it. As a rule, they are found to do better work than the makers claim for each size. Most of my work in connection with the deep-seated parts and soft tissues of the body has been done by these coils ranging from ten to eighteen inches spark, and my latest experimental work in instantaneous X ray photography and cinematographic records to show movements within bodies has been done with the large-sized coil, which I have found to be in every way reliable. It is only fair to say, however, that the earliest work was done with a large German coil (Figure 3), giving also ten inches spark.

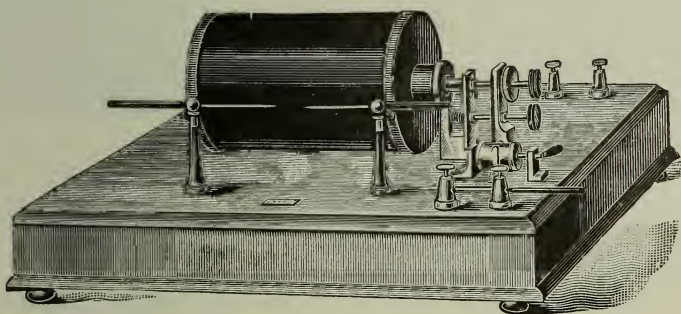


FIG. 3.—GERMAN COIL, PLATINUM AND MERCURY INTERRUPTERS.

Our experiments, however, have included tests by means of the induction coil combined with the Tesla; secondly, as indicated above, by means of the ordinary induction coil alone; and lastly, by means of an influence machine of the Wimshurst pattern, each method having its advantages as well as its disadvantages.

In Figure 4 will be seen the earliest apparatus with which I took a photograph by means of the X rays. It consists essentially of secondary batteries, a six inches spark induction coil, suitable Tesla apparatus (see Figure 5), and a Crookes' tube.

As far as our work was concerned this was discarded in favour of the simpler arrangement of the induction coil alone, but our earliest experiments suggested that this arrangement was not one to be set aside altogether in favour of what is



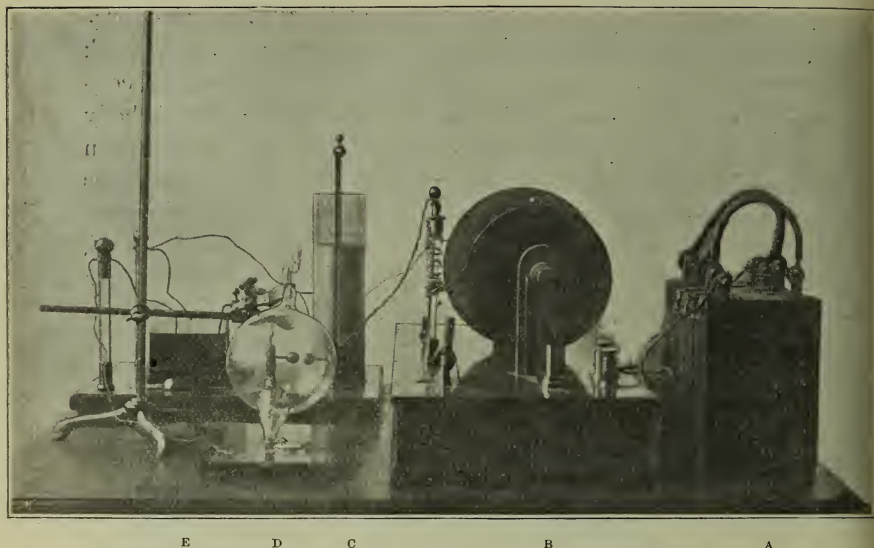


FIG. 4.—FIRST SET X RAY APPARATUS EMPLOYED—CONDUCTION COIL COMBINED WITH TESLA. A, Battery; B, induction coil; C, Tesla; D, Crookes' tube; E, dark camera slide with plate inside, with objects to be photographed on top.

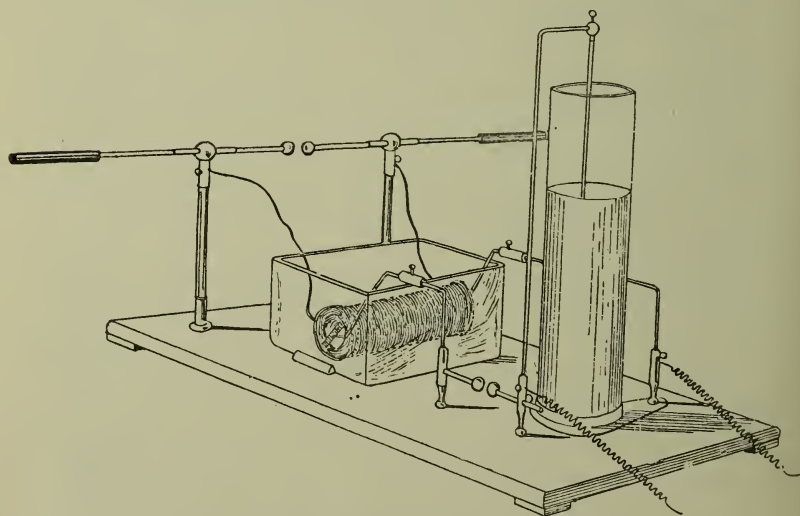


FIG. 5.—TESLA COIL EMPLOYED (Baird & Tatlock).

now the common method. For example, from experiments which I have had an opportunity of performing elsewhere, I am forced to the conclusion that, while it would be impossible to agree altogether with the statement that where the alternating current instead of the continuous is at our disposal, suitable Tesla transformers may altogether displace the more common induction coil, yet more will likely in the future be said on this point. This idea is still further strengthened by a consideration of the most recent improvements in Tesla apparatus. Professor Sylvanus Thomson, of London, favoured me with a demonstration of one of Tesla's new instruments for the production of oscillatory discharges. For this high frequency discharge, Mr. Tesla has further designed special tubes with striking results. This new apparatus, as Professor Sylvanus Thomson very properly puts it in the introduction of his presidential address to the Röntgen Society, gives us a new kind of induction coil based upon the principle of resonance, by which, without any energy-wasting spark-gap, and by the use of relatively few turns of wire, one can take the current straight from the electrical supply mains and transform it into high frequency discharges. It will be noted in the last-mentioned statement we are here dealing with an apparatus of Tesla's which does not require an alternating circuit. I am at present engaged in investigating this question, and everything goes to show that for medical and surgical purposes we have by no means reached the perfect instrument in the ordinary induction coil, but more than this one cannot at present say. The third means of exciting the Crookes' tube is by means of the influence machine, of which there are many designs in the market, but probably none better than that made by Mr. Wimshurst.

Figure 6 shows one of these machines made by Mr. Wimshurst, and now in my possession. This subject will be referred to further on when we are speaking about the results which have been obtained during our experiments. A large number of tests has convinced me, however, that for practical purposes we should not have a machine with fewer than eight plates of about eighteen inches in diameter. The instrument above figured is, next to Lord Blythswood's, the largest machine

hitherto constructed. It consists of twenty-four plates, each thirty-six inches in diameter, and is driven by an electro-motor. The great advantage which has been claimed for such an instrument is steadiness of illumination in screen work. Notwithstanding a great many experiments which I have tried with a view to doing away with the flickering, there is always a certain amount present with the coil. The influence machine in that respect at least is a distinct advantage. Mr. Wimshurst has assured me from his standpoint that the influence machine has not been thoroughly appreciated, and this has probably been the result of the general impression that the instrument is more useful for fluorescent screen work than photography. My more recent experiments, however, have caused me to doubt this statement, and the subject will also be referred to further on in the paper.

A large number of experiments early convinced me that some improvements would ultimately require to be made in the contact breaker of the coil, particularly when  
**Interrupters.** dealing with large sizes. The ordinary spring interrupter, which is supplied with coils, I found very good for photographs of the bones, and particularly those of the extremities; but when experiments led us in the direction of the deep-seated tissues, it was found that the range of which it was capable did not suit our requirements. The first observation which led me to investigate this point more particularly was the fact that in the large German coils to which a mercury interrupter was attached (see Figure 3), fluorescence as witnessed in the Crookes' tube was quite different from that obtained with the ordinary spring interrupter, which was also attached to the coil.

The subject was studied from the following standpoints: First, it was noted when using the mercury interrupter that the ampere meter registered a much higher current than when the ordinary interrupter was in use. Secondly, the spark across the discharge rods not only varied in length but in thickness, evidently in some proportion to the rise of current as indicated on the meter. Thirdly, photographs were obtained with much less time of exposure. Fourthly, the fluorescence screens were much more brilliantly illumined. Lastly, the Crookes'

tube itself was more powerfully excited. Each of these factors was taken into careful consideration, comparative tests were made on fluorescent screens and photographic plates, with the result that a considerable number of instantaneous photographs of certain parts of the body were obtained, while in the deeper seated structures more rapid results were got.

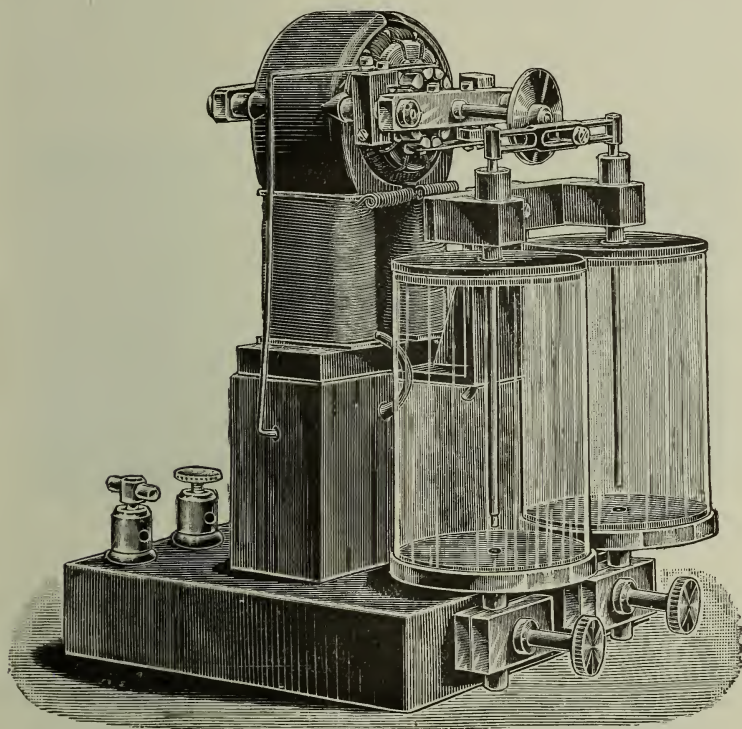


FIG. 7.—ROTATING MERCURY INTERRUPTER.

In Figure 7 will be seen another form of mercury interrupter, in which two platinum points are caused to dip in and out of mercury by the rotation of a wheel driven by a small electro-motor. This is an excellent instrument, and was supplied by Baird & Tatlock. All the mercury forms, however, have disadvantages, as the metal gets oxidised, although Mr. Apps has informed me (and I have tried the method) that an



amalgam of mercury and platinum prevents this to a large extent, particularly if a large quantity of alcohol be resting on the surface of the mercury. Under these conditions, sparking at the make and break of the point is very much reduced. With a view to obtaining still better results, and doing away as far as possible with the difficulties of the mercury interrupter, a mechanical form was made at my request by Mr. Apps. This will be seen in Figure 8. The instrument consists of a wheel driven by a motor, which causes a vertical arm to move laterally right and left. On each stud of the

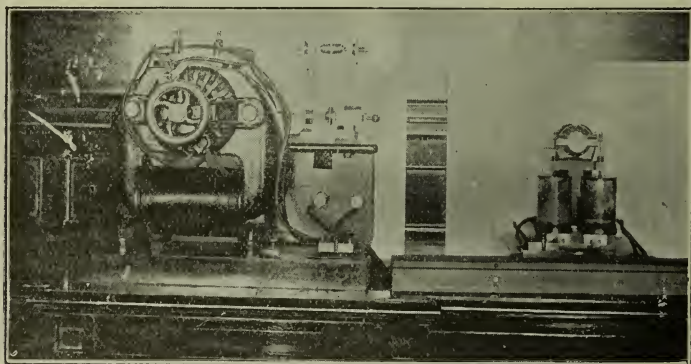


FIG. 8.—MECHANICAL AND MERCURY INTERRUPTERS.

arm we have platinum points, which come in contact with two corresponding platinum points on two upright metal arms. With each revolution of the wheel, therefore, two contacts are made. It will at once be seen that here we have a means of varying the frequency which depends upon the number of revolutions of the motor, and again by adjusting the platinum studs we can cause the points to remain in contact for a time. It will be found that when we adjust these studs by approximating them, so as to cause longer contact between the platinum points, the same thing occurs as with the mercury interrupter, viz. there is increase in the current passing to the coil as indicated on the ampere meter, sparks are thicker, the tube becomes more brilliantly illumined, and the fluorescent screen is correspondingly increased

in brilliancy. By this instrument we have gained the advantages therefore (1) of the regulation of the number of makes and breaks per minute, (2) of allowing the contact to be as long or as short as we please, thereby giving the primary coil a thorough charge before the current is broken, and (3) by this means we can measure the actual time that the platinum points are in contact during say a second or a minute's exposure, and so in repeating experiments uniformity may be obtained. I have also had an opportunity of testing Watson's "Vrill" interrupter, which is a good instrument.

It may at once be said frankly that the focus tube, to which the profession is indebted for selection to Mr. Herbert Jackson, is the one used in the hospital. Many forms of it have been tried. The penetrator, as recommended by Watson, is good. A large number have been

#### Tubes.

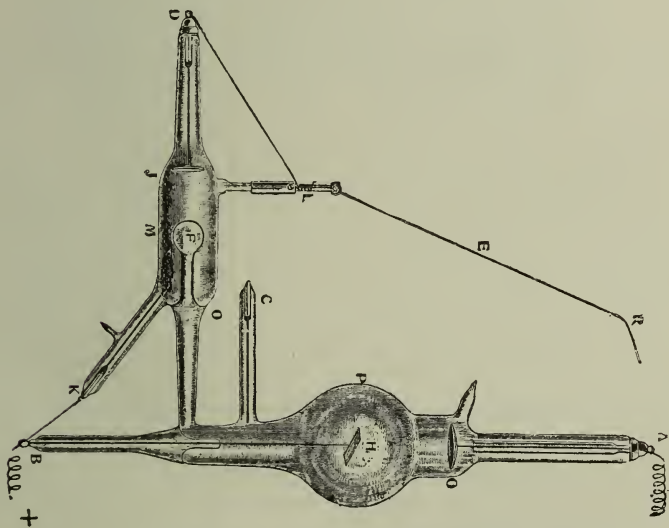


FIG. 9.—QUEEN'S TUBE. +, —, Positive and negative wires; H, anti-cathode; O, cathode; R, inner bulb containing chemical substances; J, M, lesser bulb; E, R, bridge adjustable for distance between R and A.

supplied by the General Electrical Co. The only novelty of late has been one or two tubes of Queen & Co., Philadelphia. This is a modification of the focus tube as represented in Figure 9. The principle may be described by saying that in

the small bulb a certain chemical is given off when heated, and it is again absorbed when the tube cools. The arm seen above is adjustable, so that a gap can be arranged between *g* and *a*. By this means the tube can be kept at a particular vacuum for any length of time, and the vacuum is kept constant, as the tube is self-regulating.

With regard to the practical use of the tube, it may here be stated that as a rule, with ordinary tubes at least, heating by means of the Bunsen or spirit lamp is the plan adopted when the vacuum gets too high. I have also made use of Mr. Wimshurst's suggestion, to place a piece of tinfoil or gold paint round the neck of the tube. This to a large extent does away with the necessity of heating, and to a very considerable extent regulates the vacuum.

Notwithstanding the above statement, however, I think in order to get the very best results the vacuum of the tube ought to be regulated for the particular coil in question. In designing the tubes I paid special attention, first, to the fact that the tube is very long in measurement, eighteen inches at least in its long diameter. This prevents sparking across the outside surface of the glass, although as the vacuum rises it probably increases the risk of injury to the tube. Secondly, the discs passing into the tube are very thick. Thirdly, as described in a paper to the *Lancet*, in the early part of 1896, I made the anodes adjustable, so that we may find the exact point at which the best result is obtained. Mr. Campbell Swinton makes the cathode adjustable, and I have found it useful to take advantage of another suggestion by this gentleman, namely, to embed the platinum of the anti-cathode in a thick block of aluminium; this prevents heating. There is no detail of too little importance to be attended to. For example, the glass (German) must be thick enough to allow of heating, and yet not too thick to obstruct the passage of the rays. Figure 10 shows the design of the pump, for many details of which I am indebted to Dr. Bottomley, who was good enough to give Mr. Otto Müller, who made it, many suggestions, the result of his own experience.

As indicated above, the voltmeter and ampere meter should

always be in the circuit. Lord Kelvin's meters are excellent and reliable, while Newton has devised a cheaper instrument which combines both measurement of volts and amperes in one. This I have also used with advantage.

**Accessories.**

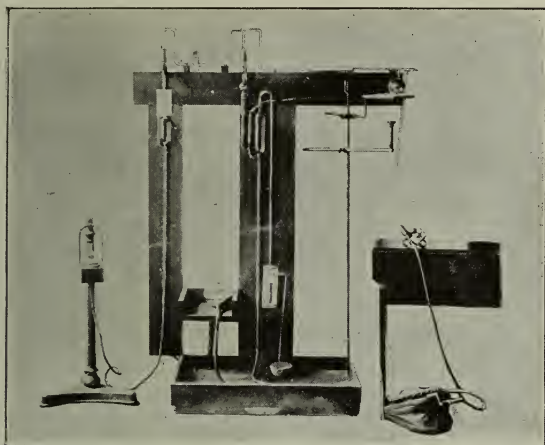


FIG. 10.—MERCURY PUMP FOR EXHAUSTING CROOKES' TUBES.

Several of these are in the market, the best being one of calcium tungstate as supplied to us by Schall. Where quick exposure is required it is useful, but owing to the grain of the salt which appears on the plate our experience is to discard it, and particularly in instances where a well-defined photograph is required. Speaking generally, we may say that the use of the cryptoscope has been discarded for the dark room. Our best effects on screen-work have been obtained by causing the room to be made absolutely dark, and I have designed a special stand for holding the Crookes' tube, and enclosing it in dark cloth, so that even the light of the tube itself is excluded.

**Intensifying  
Screens.**

Experiments have been tried with a large number of fluorescent salts; amongst others may be noted barium-platino-cyanide, potassium-platino-cyanide, lithium-rubidium-platino-cyanide, calcium tungstate, schaelite, urynal fluoride. Specimens of these screens have been made by myself, and afterwards with a

**Fluorescent  
Screens.**



view to testing more carefully, by Kahibaum, whose excellent materials are well known. No one who has worked with the potass salt, especially if it be hydrated, can doubt its superiority in fluorescence and definition; but the disadvantages are that the salt does not keep so well, and it is difficult to keep it hydrated. When we get really good specimens of the barium-platino-cyanide salt, it approaches very nearly to the potassium. Its advantage is its stability. Screens made of this material last for a long time, and when the salts have been carefully prepared originally, the screens stand a good deal of tear and wear. The story of the calcium tungstate is an interesting one. It may at once be said that after eighteen months' careful testing with the calcium tungstate material, prepared for me by many chemists on this side of the Atlantic, as well as specimens got from America, I have no hesitation in saying that the salt is distinctly inferior to the barium-platino-cyanide. It is true it is cheaper. In addition to its inferiority by way of fluorescence, an observer who has to examine a number of cases gets annoyed by the persistence of images. Mr. Edison was the first to recommend calcium tungstate, and his results were announced by cablegram some time after we had made our earliest experiments in fluorescence in this hospital. A great deal was claimed for calcium tungstate, and subsequent writers, such as Dr. Morton, seemed to endorse the statements; nay, more, some did not hesitate to say that calcium tungstate, crystallized and specially prepared, gave six times better results than the barium salt. My only object in working with the X rays was, of course, to find out what would be most useful in the examination of medical and surgical cases; and, with such statements before me, I thought it my duty to have specimens of these salts prepared. Through the kindness of Dr. Frank Bottomley and Messrs. Baird & Tatlock, who prepared some crystalline material from the amorphous form, I had many specimens of these salts prepared. In no instance could I come to the conclusion that barium-platino-cyanide was inferior to calcium tungstate, and this notwithstanding the great authority who had recommended it. As this statement had been endorsed by Dr. Morton, of New York, one of the best known experts on the other side



EXPERIMENTS IN SOFT TISSUES.—NORMAL HEART.

First Photograph of this Organ.



of the Atlantic, I wrote explaining matters, and requesting him to furnish me with some specially prepared material, and likewise to choose the best fluorescent screen which he could obtain. This he kindly did, and I obtained them from Messrs. Jackson & Ailsbury, of New Jersey. A most careful series of tests led me again to the conclusion that the calcium tungstate salt was inferior. On the strength of these experiments, again I wrote to Dr. Morton who, in reply, was kind enough to inform me that he believed the erroneous impression of the extra value of calcium tungstate was due to those in America having had inferior specimens of barium-platino-cyanide. Although these statements appear in his book, he acknowledges now that they were the result of the earlier experiments, and he further informs me that the makers of screens, even in the United States, have found the calcium tungstate displaced by what we had from the first found best. Lithium-rubidium screens are also very good, but in my hands I have found nothing to recommend it over the barium-platino-cyanide. Urynal fluoride and calcium tungstate may be used with great advantage as intensifying screens to hasten the exposure, a matter of some importance where for any reason one does not wish to expose the patient to a prolonged sitting.

During the past two years many improvements have been made in the manufacture of screens, and, no doubt, those so commonly used and made by Kahlbaum are exceedingly serviceable. This chemist has succeeded in making the surface exceedingly smooth, but at the expense somewhat of sharp definition. To get the best results a great many experiments were performed with a view to discovering the exact size of crystal (say of the barium salt) which would be most efficient, and, generally speaking, it may be stated that within limits the coarser crystals are the better. When the barium-platino-cyanide salt is ground too finely a certain amount of effect is lost. Notwithstanding the various improvements, however, the ideal has yet to be got. It is quite evident, in the first instance, that we are utilizing nothing like the number of X rays which come from the focus tube in this work, and probably the same remark is quite correct if applied to photography as well. I have placed four screens in



front of each other at a distance of one foot apart, and found that the last one was sufficiently illumined to show the bones of the hand quite distinctly. Experiments were tried to stop more of the rays by increasing the thickness of the layer of crystals on the screen, but still the majority seemed to be passing straight through, and naturally there must be a limit to these experiments, because after certain thickness the image becomes very indistinct. For sharp definition I have never seen anything equal to the hydrated potassium-platino-cyanide screen.

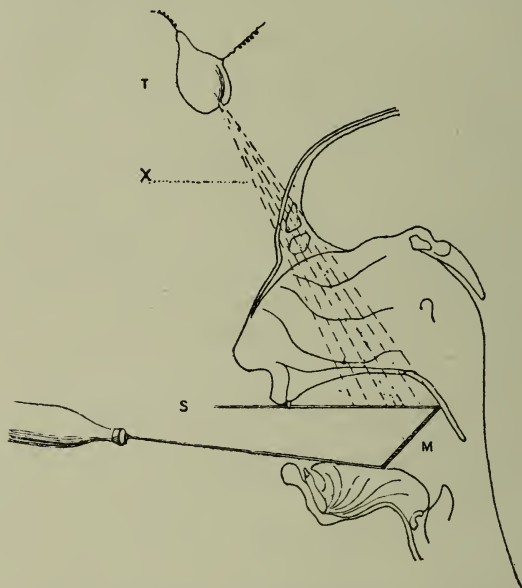


FIG 11.—METHOD OF EXAMINING WITH SCREEN IN MOUTH. T, Crookes tube; M, ordinary laryngeal mirror; X, Röntgen rays; S, screen.

Screens may also be utilized in different cavities of the body. For example, I have designed a screen for the examination of the hard and soft tissues in the region of the bones of the face, and also those in the region of the neck and larynx. Figures 11 and 12 will explain these.

Briefly stated, they may be described as follows:—The fluorescent screen is placed inside the mouth and the lamp outside. Small discs of glass are coated with the salt and covered with aluminium; or, again, tongue depressors consisting

of flat strips of glass covered and coated in the same way may be employed. By placing the tube outside I am able to get an image of the septum and other parts of the cavity of the nose on the fluorescent screen in the mouth. In the same way the roots of the teeth may be seen. If the surgeon desire to examine the parts below or above the jaws, he simply puts the Crookes' tube below or above and passes the rays through

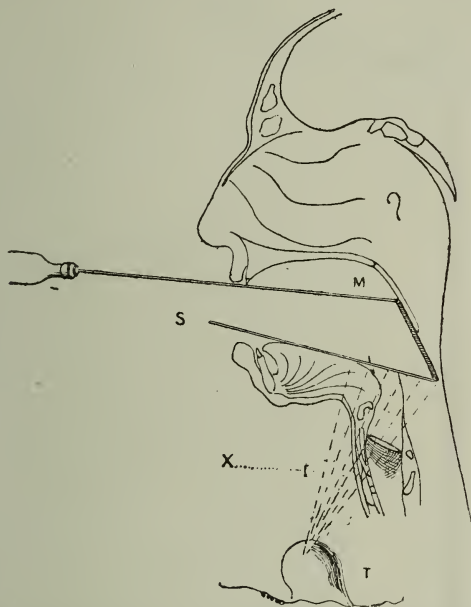


FIG. 12.—METHOD OF EXAMINING WITH SCREEN IN MOUTH. T, Crookes' tube; M, ordinary laryngeal mirror; X, Röntgen rays; S, screen.

the tissues. If he desire to examine the tissues externally, that is to say, to pass the current through the neck, he places a small fluorescent screen on one side and removes the Crookes' tube to a suitable distance. By this means I have been able to demonstrate the presence of foreign bodies, and need hardly add they are more easily photographed.

In Figure 13 will be seen a stand designed by me, and made by Messrs. Baird & Tatlock, for holding Crookes' tubes. It is six feet high, and has two non-conducting arms on which rest the wires coming from the coil. Its principle is simply that of the ordinary chemical stand, but I

#### Accessories.

have found it most useful whether for photographic purposes

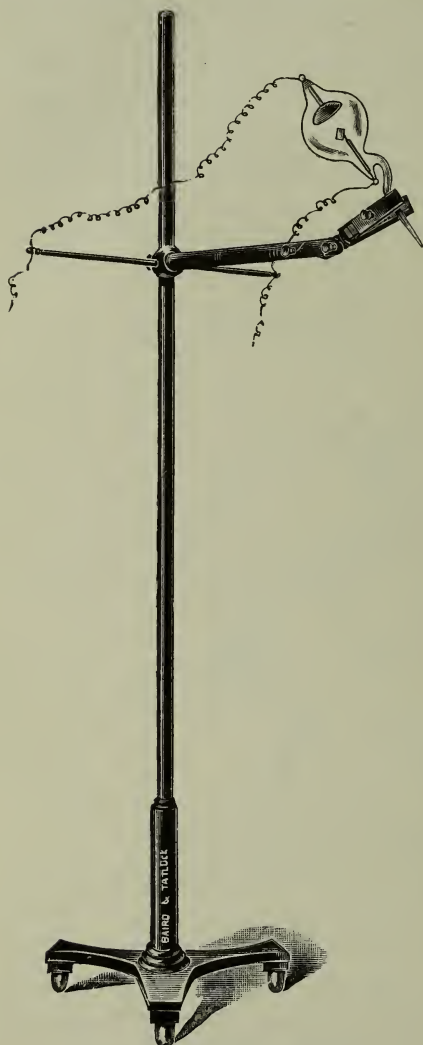


FIG. 13.—X RAY STAND (Macintyre).

or for examination by means of the fluorescent screen. By the universal movements at our disposal we can arrange the tube for any part of the body, whether the patient be standing or lying down.

The condenser is a very important part of the apparatus, and while

**Condensers.** it is usually placed in the base of the coil, it may be kept separate. As it is exceedingly important that the make and break of the current should be sudden, this part of the apparatus aids by preventing the spark of the extra current, due to self-induction in the primary circuit, passing across the interrupter. I have more than once found, when it was a little difficult to work, that something was wrong with the condenser, and there are times when it is advisable to have extra con-

densers in case of injury to the one in the base of the coil.



EXPERIMENTS WITH SOFT TISSUES OF NECK,—HUMAN LARYNX.





## APPLICATION OF THE RAYS.

From my first experiments I have steadily insisted upon the careful appreciation of three different factors in order to get good pictures or shadows on screen: firstly, definition; secondly, penetration; and, thirdly, arrangements for selecting particular tissues or parts of the body. By this last statement I mean that sometimes it may be desired to photograph a particular object in the body and to omit parts which lie in front or behind it. Take, for example, the case of the heart. We may wish to photograph the heart without showing the sternum and ribs, or, on the other hand, we may wish to photograph the heart or an aneurysm without seeing the spine.

**General Considerations.**

With regard to the first, viz. definition, it has been clearly enough established that the rays proceed somewhat in the form of a cone, the apex of which is at the anti-cathode within the tube. It naturally follows that, if the object be removed from the plate, ill-defined shadows will be obtained, and generally speaking, therefore, it is desirable to have the object as near the plate or screen as possible. The converse also holds good, because, where we have the object at some distance from the plate or fluorescent screen, the removal of the Crookes' tube to a greater distance improves the definition. That is to say, there is a relationship between the distance of the object from the plate or screen and the point at which the tube ought to be situated. Mr. Campbell Swinton has shown that the cone is hollow, but notwithstanding this fact the above statement within limits holds good. While it is not fair to say generally that the fluorescent screen is always a guide to what will take place on the photographic plate, nevertheless it is a useful rule to examine the part to be photographed first with the fluorescent screen. Generally speaking, the nearer the object to the plate, or, failing this, the further we can afford to remove the tube from the object, the better will be the definition. It is always to be remembered, however, that removal of the tube to a certain extent diminishes the power and lengthens the exposure. It is for this reason that I have

long advocated highly exhausted tubes to suit more powerful apparatus.

With regard to the second point, viz. penetration, it is useful to remember that the difficulties in getting through the thicker parts of the body are to be explained within limits by the fact that tissues oppose the rays according to their densities. As a result of careful experiments, I have come to the conclusion that when we have penetrated the tissues it does not take much to act upon the photographic plate or fluorescent screen. With my large coil and tubes in good working order I have had little difficulty in sending the rays through four persons (even six) standing in front of each other. I have likewise passed the rays seventeen feet across the room and through a large thick wooden partition in sufficient quantity to see shadows of the bones of a person's body who was standing inside one room while the observers were in the next chamber. I have also sent the rays over forty feet in air, then through the door in an adjoining building, and in sufficient quantity to show distinct fluorescence on the screen, although the rays had passed through the above mentioned wooden door, painted on both sides with lead paint. This great penetrative power is useful in the deeper seated tissues of the body—a fact which I have found of importance in taking more rapid photographs of the soft tissues of the body. In taking photographs in the deeper seated structures of the body, and more particularly when dealing with the hard and soft tissues, this is an important point for consideration.

There is yet another interesting point which it may be convenient to consider in connection with the above mentioned subjects, and that is localization of objects. In the early part of 1896 I conceived the idea of taking two images by means of two tubes, or by one tube first and then removing it to a distance. Two images were thus got on the screen or photographic plate. My friend, Mr. James Buchanan, M.A., of Peter's College, Cambridge, worked this out mathematically at the end of April, 1896. Since then many other workers, such as Mr. Ernest Payne and Dr. Mackenzie Davidson, have described different apparatus by means of which calculations may be omitted, and there

**Localization  
of Objects.**

can be no doubt that surgeons can now have a very definite idea of the exact localization of a particular object in the tissues.

I have also found the study of the appearances of the tissues at different conditions of the tube useful in attempting to photograph or see shadows of particular tissues of the body. For example, for the softer tissues which are less dense, the vacuum in the tube should be low. If, on the other hand, we wish to bring out the bones, one can, by raising the vacuum, get quicker and better results. Lastly, if it be a foreign body of dense structure, such as metals which are opaque to the rays, then a higher vacuum may become useful. These statements to a certain extent are merely generalizations, but modifications of the tube may be obtained for different densities of tissue. It is always necessary that the operator should define first of all what he desires to obtain. The regulation of the vacuum is of the utmost importance. Further, I have found two methods of advantage: firstly, either to keep a set of tubes at low, moderate, and high vacua, or, secondly, to use one of Queen's tubes, as described in a former part of this paper, whereby the vacuum may be varied and kept the same throughout an exposure. The disadvantage of the latter is the expense of the tubes.

**Different  
Conditions of  
the Tube in  
the Hard and  
Soft Tissues.**

In a certain number of cases it is possible to get the camera in front of the fluorescent screen and to take impressions of what is seen. This at present only applies to the extremities of the body, and its great disadvantage lies in the long exposures required. As a result of photographing with a number of different screens, I may say that I have found the potassium-platino-cyanide to be most useful owing to the blue colour and great actinic power. When this is done the operator must place a sheet of lead perforated for the lens in front of the camera large enough to cover the front, otherwise there would not only be a reduced image of the fluorescent screen, but also an enlarged image of the lens in front of the camera caused by the rays passing through the front of the apparatus itself. This

**Photographs  
of the Fluor-  
escent Screen  
itself by  
means of the  
Camera.**



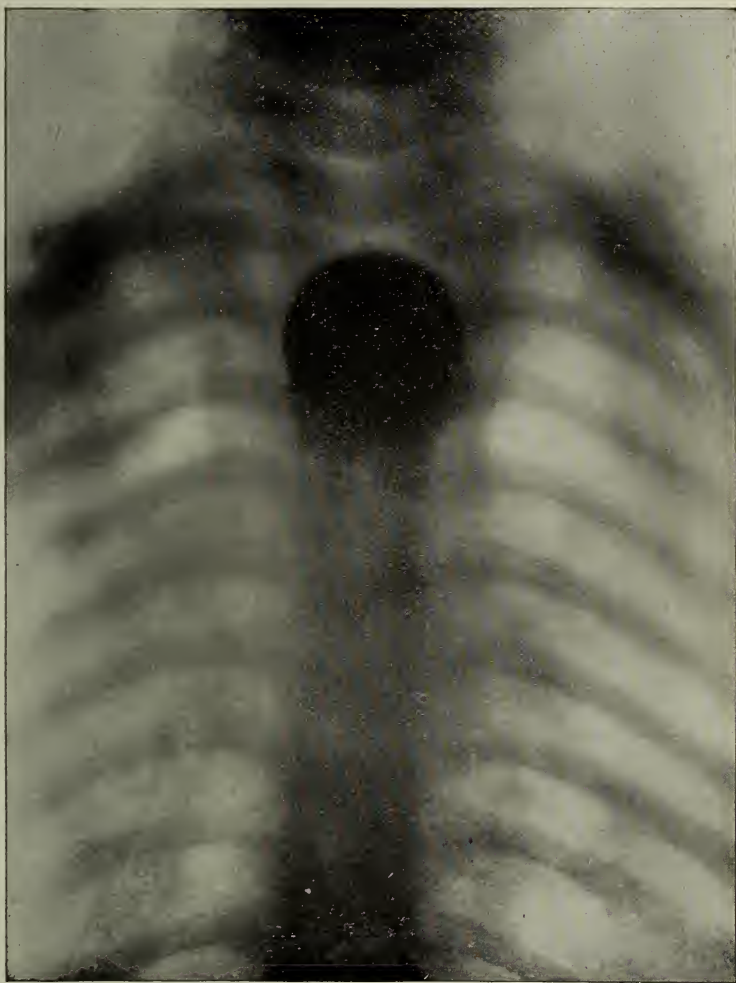
method has its many disadvantages, but if it could be further cultivated it would certainly be desirable, as we could at once reduce pictures from life-size to small dimensions—a fact which is not only of great importance in saving material, but condensed pictures give sharper definition. Even a diffused round shadow of a coin in the body becomes a well-defined disc when reduced from 15 by 12 to lantern slide size, or quarter plate.

This apparatus is intended to enable one to test and compare the intensity of the focus tubes and the sensitiveness of fluorescent screens. I have found the apparatus useful, and, briefly described, it consists of a polished mahogany case, in the interior of which are twelve squares of tinfoil of various thickness, each square being provided with a lead figure. These are numbered from eight to thirty or more, if specially made. By simply looking through this meter one can get a fair idea of penetration and likewise of the sensitiveness of a particular screen.

With regard to photographic material, the majority of my experiments have been done with the Paget 50 plates.

**Actinometer**  
**(Schall).** Lumière's have been tried, and also several plates sent by the General Electrical Company, Berlin. While I am not desirous in the least to minimize the advantages of quick photographic plates, or those of thick coating as recommended by Oliver Lodge, or double coating on both sides of the glass as recommended by others, nevertheless we have found a good Paget 50 plate very useful, and my experience has been that these plates are very constant and reliable. Moreover, I have paid more attention to the condition of the tube. The sensitive papers recommended by Eastman have also proved useful in some cases. Surgically speaking, it has been found of advantage in some instances to place a piece of sensitized paper on the top of the negative, the latter being reserved for a permanent impression, while the paper may be at once developed, if required by the surgeon for immediate apparatus. For the most part hydro-kynone and pyro have been our developing solutions.

In order to facilitate the work it is necessary that the



FOREIGN BODIES.—HALFPENNY IN OESOPHAGUS.

Case of Dr. Rutherford, referred to in Presidential Address by Lord Lister, Brit. Assoc., 1896.



apparatus should be arranged so that every part is under control. Further, suppose a number of experiments have to be tried in succession, say where we wish to compare the results in different photographs, every factor should be kept as nearly as possible the same during each experiment. In order to obtain this every care should be taken in arranging the installation. Firstly, the current which is going to the primary coil must be kept as nearly as possible the same; the volt and ampere meters should be watched, and the slightest variation in readings immediately corrected by the variable rheostat. Secondly, the discharge rods should be approximated and withdrawn until the exact distance between the two is found which will excite the Crookes' tube. This is of great advantage in saving the tubes, because the slightest increase in the vacuum causes sparking across the gap between the discharge rods. Thirdly, the same state of the coil should be preserved throughout the experiments, no change being made by way of alteration in the condensers or other parts in the base. Fourthly, by means of a mechanical interrupter, as described above, one can regulate the number of contacts per second by counting the revolutions of the wheel. Moreover, as we have said, by adjusting the studs on the vertical arms, we have a register of the exact time during which the current is actually passing through the primary coil. This is an advantage of the mechanical interrupter which cannot be got by any spring arrangement. Fifthly, the condition of the tube should be most carefully regulated; and, after getting the desired excitation, a current of hot air, or a spirit lamp, or a bunsen burner, or the application of a piece of tinfoil round the tube should be resorted to in order to keep the vacuum the same throughout. The Queen's tube makes this very easy, but in any case the actinometer may be employed as an extra test. The thickness of the dark covering for the plates and the proper distance between the plate or screen, object, and Crookes' tube should be carefully adjusted. It is only by keeping such factors as nearly as possible constant that a series of experimental results sufficiently good for comparison may be got. Figure 14

**Arrange-  
ment of  
Apparatus.**



shows how the parts may be arranged with different switches at the right of the coil, so that one may introduce the mechanical, mercury, spring, or any other interrupter at will.

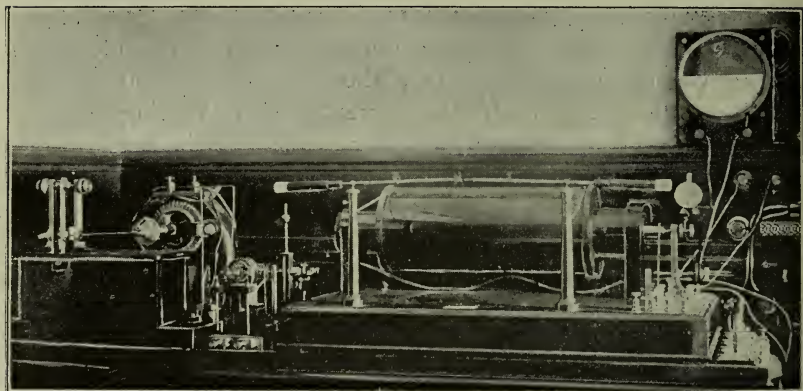


FIG. 14.—INTERRUPTER, COIL, ETC., WITH VOLT AND AMPERE METERS.

#### RESULTS.

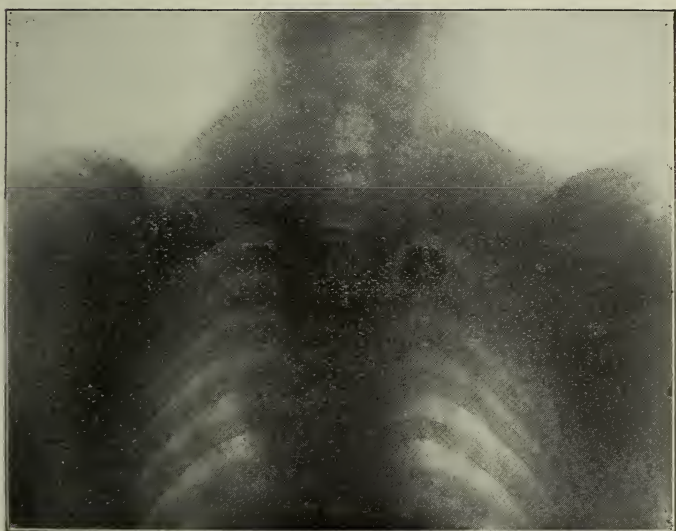
As already indicated, the apparatus required for the production of X rays was added to the electrical installation of the Glasgow Royal Infirmary in the month of **General.** March, 1896. Earlier experiments had, however, been performed with a view to proving the value of the new agent or otherwise. The managers cordially co-operated in making the necessary arrangements, and from then until now the X rays have been constantly used in the house, although more in the surgical than the medical department. The most of the work accomplished in the former department has been undertaken by Dr. Faulds, while the medical has been looked after by Dr. George M'Intyre. As a rule, it may be stated that permanent and more valuable results have been obtained from the photographic plate; but as the fluorescent screen has become better known, a fair and important share of the work of diagnosis has been carried on by the latter. It naturally follows also that, in the first instance, the work was mostly confined to the detection of

the presence of foreign bodies. Then followed one of its best and widest uses, viz. the detection of the true lesions in dislocations and fractures. As we often find in other branches of science, comparatively little difficulty was experienced in attaining certain advances, but after a point the difficulties increased very much. While advances in methods made rapid strides for the first few months, every additional step of late has been made with greater expenditure of time and energy. This fact applies more particularly to the differentiation of the soft tissues in the adult subject. It may be interesting to note, however, that as early as the first week in March, 1896, the fluorescent screen was being used for diagnosis of minor lesions in the extremities. On the 16th March foreign bodies in the skull of a dead subject had been distinctly seen, and the spine in the living adult subject had been photographed, the plate distinctly though faintly revealing the presence of the heart as well. On the same date well-defined shadows of the bones of the upper extremities, and most of the bones of the lower extremities, had been seen. In the same week a fluorescent screen, to be placed inside of the mouth, and intended for examination of the larynx, neck, face, and bones of the hyoid, had been employed, and photographs distinctly indicating the position of the cardiac area had been obtained. On the 26th of the same month shadows of the spinal column, ribs, and thorax were well seen on the fluorescent screen, and it is interesting also to note that during this week movements, which clearly indicated the cardiac area, were observed. Foreign bodies were detected in the thoracic cavity in the first week in April, 1896; and, on the twelfth day of the same month, the first *instantaneous* photograph of the bones of the hand was obtained. During the latter period our attention was directed to the soft tissues of the body; and although shadows of the cardiac area had been previously photographed, and the movements in that region detected, the first well-defined indications of the cardiac area were obtained early in the first week in May. By then alterations in the cardiac area were not only detected by means of photography, but their shadows were also observed on the fluorescent screen. Some

of the soft tissues had been seen and photographed a considerable time before this. For example, photographs of the neck showing the hyoid bone, epiglottis, arytenoid cartilages, opening of the oesophagus and spine had been shown at the British Rhinological and Otological Association in London on the 4th April. Early in July a case of renal calculus was detected, and afterwards successfully operated upon by Dr. James Adams. About this time a really successful series of photographs of the pelvic region had been obtained, including hip joint disease. In the early part of 1897 the advances in photography had enabled us to have a series of cinematographic records of the movements of some of the lower animals, such as the frog's legs, and this, when thrown upon the screen by means of the magic lantern, showed the internal movements. It will be quite impossible, however, to do more than indicate some of the important groups of affections in which the rays have been employed in this hospital.

A large number of cases have been examined for foreign bodies. Naturally most of these have been in the extremities, and the commonest objects have been pieces of glass, needles, coins, and a few bullets or pellets in gunshot wounds. While the majority of these foreign bodies have been detected in the extremities, examples have also been obtained in the skull, thorax, and abdomen, the last region least frequently of all. In the report of cases which have come under the care of Dr. Faulds, he includes foreign bodies in the skull. I have detected a piece of metal tube in the antrum of Highmore, more than one pin in the region of the larynx, while a most interesting photograph of a case under the care of Dr. Rutherford, taken in April, 1896, is reproduced here, and was referred to by Lord Lister in his presidential address to the British Association. The shadow of this coin was seen by means of the fluorescent screen, but a photograph was also obtained. A similar case of coin in the oesophagus was recorded subsequently by Dr. Faulds, and successfully operated upon by Professor H. E. Clark.

A very large number of these have naturally been examined by means of the X rays. Diagnosis has in many cases been confirmed; in others, mistakes relating to dislocation and frac-



FOREIGN BODIES.—HALF-SOVEREIGN IN RIGHT LUNG.





tures have been corrected. Many photographs of these lesions in the extremities have been obtained, but others less common have been noted, such as fracture of the upper jaw due to a crush, a case which came under the care of Mr. Pringle. In some instances the rays have been useful in detecting the position of bone during repair, as in one of the earliest cases in which the position of the two ends of the radius, sutured by Dr. Barlow, was determined. Useful instances of diagnosis in the region of the hip have been noted. An extremely interesting point in such cases was seen on examination of the injured side. The shortening, which was very great in the young man's case, was clearly due to the dwarfing of the right side of the pelvis and femur. Examination of the healthy side will show the cartilaginous structures still in existence and providing for growth, while on the other development had been arrested.

**Fractures  
and  
Dislocations.**

In a few instances I have been able to note caries in the cervical region. In one case (Dr. Rutherford's) a swelling of the foot was clearly shown to be due to cartilaginous growth, a point of interest in diagnosis. Dr. George M'Intyre has put on record changes in chronic pulmonary osteo-arthritis, the case being under the care of Mr. Lindsay Steven, and in more than one case the rays have by photography shown some interesting details in cases under Dr. M'Vail of rheumatic arthritis.

**Other  
Conditions  
of Bone.**

It is particularly my desire in this *résumé* to point out the lesions and regions in which it might be fairly claimed that the Röntgen rays have taught us what could not have been otherwise known without its aid, and in all fairness we might also include conditions in which corroborative evidence has been obtained by means of the rays. As far as we have gone, therefore, speaking of foreign bodies and alterations in the hard structures, I think our experience has been like that of many others, sufficient to justify the statement that in these situations and in the regions indicated we may safely make the claim. In what is to follow, however, the case is more difficult to state with all fairness. To begin with, I frankly admit that in the vast majority of medical as opposed to

surgical cases, and where the soft tissues are involved, whatever may be our ideas of promise in the future, much remains to be done. For the most part, I think it fair to state that limited information has been obtained which would not have been got or inferred by other means of diagnosis. The most that can be said is that corroborative or supplemental evidence has been obtained. I am quite well aware that others have claimed more than this. For example, Dr. Walsh, in the *Röntgen Rays* for 1897, quotes Dr. Coupland's case, the words being, "in a case of deep aneurysm of the chest, the diagnosis was cleared up by the fluoroscope." Dr. Schott, whose work is well known in the treatment in cardiac affections, in the early part of 1896 communicated with me with a view to obtaining information of the methods adopted in photographing the heart, and I understand he now claims that important results have been obtained in diagnosis. Although I have since communicated with him asking for information, I am not in a position to say anything, as promised communications have not yet come to hand. Under my own observation, I may say, however, that I have got some information as to the exact destruction of bone in the upper jaw, caused by the advancing malignant disease. I have photographed and seen as shadows enlargements of both ventricles in a case of acute pneumonia, the first photograph being one of a case under the care of Dr. M'Vail. I have also distinctly seen on the screen and photographed enlargements of both ventricles of the heart, while searching for a case of pressure in the recurrent laryngeal nerves. I have obtained photographs and seen shadows of aneurysm within the thorax.

Speaking more particularly of the thoracic region, in a number of cases the borders of the heart are well defined on the screen, and movement can be made out. This is not sufficiently definite to make out all the movements of the different parts of the heart. The aorta can in many cases be very well seen, and less frequently the border of the right auricle.

The diaphragmatic movements are interesting both in health and in disease. For example, the structures may be seen

pushed upwards where there is pressure in the abdomen, and limitation in the descent of the diaphragm may be made out where the lungs are not fully expanded, and this from different causes. The rapidity of the movement of the diaphragm can easily be detected, and even irregularities in its action may occasionally be observed on the screen.

In the region of the abdomen, like other workers, I have experienced the greatest difficulty. The most interesting case is that above mentioned, in which a phosphatic mass in the kidney was detected and afterwards operated upon by Dr. James Adams. I have, however, failed completely in one instance where the surgeon afterwards operated and found a renal calculus. I may say, however, that my own work in the hospital is altogether in connection with diseases of the nose and throat, and consequently I have had little opportunity, unless when called upon to give assistance to some of my colleagues, of exploring or examining the abdominal cavity. Lest any of these remarks should be misleading to others who may be interested in this particular work, I repeat that my personal experience has been altogether by way of corroboration, and most of the lesions could have been inferred by other methods of diagnoses.

In conclusion, I should like to say that our experimental and routine work in the hospital has been singularly free from injuries. In my own case, as reported in the *Lancet*, a slight dermatitis ensued, but that was after working for nights in succession with the left hand in front of the X ray tube. At present we are undertaking a series of experiments in the hope of showing what actually is the dangerous condition of the tube, electrical or otherwise, which has caused such a lesion to be put on record. We have also undertaken a considerable number of experiments as published in *Nature*, with a view to obtaining any indications of polarization, refraction, or reflection, the aim of such work being easily understood by those who really appreciate the great advance that would follow the discovery of any such means. As yet the results have been purely negative. Notwithstanding these disadvantages, efforts are continually being made to obtain better results from improved apparatus, familiarly with the appearances of lesions



on the screen, and, last of all, by comparative results of the transformers, particularly the relationship between the influence machine and the coil. While there is much yet to be done, it may be fairly claimed that the results in a certain number of cases have thoroughly justified the managers in establishing and equipping this special department in the hospital.

#### NOTE.

A few reproductions of photographs are interleaved, mainly with a view to showing the first which were obtained of the hard and soft tissues at the periods indicated in the paper.



EXPERIMENTS IN DEEP STRUCTURES.—FIRST PHOTO OF PELVIS  
SHOWING OLD DISEASE OF HIP JOINT.



## ON THE PATHOLOGY OF PERNICIOUS ANAEMIA.

By WALTER K. HUNTER, M.D., B.Sc.

THE word Anaemia, used as a general term, implies a deficiency of blood in the circulation. By that we mean not so much a defect in bulk, as in the constituent elements of the blood—the haemoglobin and the red blood corpuscles. Considering anaemia then, in this general sense, *i.e.* as a physical sign expressed in terms of the amount of haemoglobin and of the number of red blood corpuscles, we find that it may be produced in one of three ways: (1) By direct loss of blood, (2) by diminished production of blood, and (3) by increased destruction of blood. In the first group we include the anaemias following on haemorrhage, whether internal or external. The second group is more difficult to define; but any cause which impairs the nutrition of the tissues generally must also affect the healthy activity of the blood-forming organs. Thus, insufficient food, insufficient exercise, indigestion, lesions in vital organs, may all determine a certain degree of anaemia.

The increased destruction of blood of the third group may be brought about in several different ways. For example, the plasmodium of malaria causes destruction of many red corpuscles; and, indeed, in all the fevers and wasting diseases there is doubtless some destruction of blood, due either to the direct action of a poison in the circulation or to the leucocytosis resulting therefrom. Certain drugs,<sup>1</sup> too, are known to destroy red blood corpuscles, but they do it in different ways. For example, glycerine, when injected into the circulation, acts on the red corpuscles, separating them from their haemo-

<sup>1</sup> Hunter, *Lancet*, Vol. II., 1892.



globin, and produces thereby a typical haemoglobinuria. Toluylendiamin, on the other hand, confines its destructive action chiefly to the blood in the portal area; and the large increase of iron pigment subsequently found in the liver is due to the corpuscle disintegration which this poison produces.

These, then, are some of the causes of anaemia. But in investigating the pathological anatomy of a disease a consideration of the causes forms but the introduction to the inquiry, and it is the effects with which we are more particularly concerned. We have seen that anaemia implies some defect in the constituent elements of the blood. Now it is on the blood that the tissues depend for nourishment and aeration, so that ill effects must be looked for as a result of this defective blood supply. The most common of these is fatty degeneration, and it is found chiefly in the heart-muscle and liver-cells. The fatty changes in these tissues seem to depend on their defective supply of oxygen, the result of the diminished amount of haemoglobin, for this is the vehicle which carries the oxygen.

Another change is sometimes met with in the presence of a deposit of iron pigment in the liver cells. It is said to be a constant appearance in cases of pernicious anaemia, and it is, as we have seen, also found in animals after the administration of toluylendiamin.

But there are still other changes to be noted. We know that a loss of blood cannot take place without some effort on the part of the organism at repair. Evidence of this is shown in the increase in size and activity of the various blood-forming organs. For example, the change in the marrow of the long bones from a fatty to a red lymphoid tissue is nothing but the outcome of a demand for more red blood corpuscles. It is more difficult to say what the increase in size of the spleen and lymphatic glands so often met with may be due to. In some cases it is only the spleen or possibly one single group of glands that is found enlarged, while on the other hand there are cases where the whole of the adenoid tissues throughout the body seem to be involved. Most probably it is some poisonous substance in the blood or lymphatics which causes this hypertrophy of adenoid tissue. Certain of these poisons

would seem to stimulate the glands to growth, while others, in addition, to stimulate them so that they discharge the products of their growth (*i.e.* leucocytes) into the circulation.<sup>1</sup> This may explain why in some cases there is but slight increase of white corpuscles in the blood, while in others the white corpuscles are increased to such an extent as to be equal in number to the red.

The changes, then, which follow anaemia are not wholly confined to the general tissues and blood-forming organs; for the blood itself, besides a deficiency in haemoglobin and red corpuscles, presents other important changes which must not be overlooked. We know that following an haemorrhage of any considerable extent, as well as in many other cases of anaemia, nucleated and other forms of immature red corpuscles are to be found in the circulation. This is evidently due to there being such an urgent demand for a fresh supply of blood to make up for what has been lost, that red corpuscles are hurried into the circulation before being fully developed. These embryonic corpuscles seem to be of little use to the organism, and their presence in considerable numbers in the spleen in such cases suggests the idea that they are soon withdrawn from the circulation and destroyed. The increase of leucocytes, on the other hand, when not excessive, should be of much benefit to the organism on account of the phagocytic or protective properties which they possess. But when in excess there is reason to believe that their rapid formation causes many of them to enter the circulation immature, and as such, they more probably succumb to rather than counteract any poison which may be present. This unhealthy condition of the white corpuscles also explains why the vessel-walls so easily rupture, and why haemorrhages are so frequent in the group of diseases we are at present considering.<sup>2</sup>

Turning now from these general considerations to the subject with which we are at present more particularly concerned, the pathology of pernicious anaemia, we find, to begin with, that the term itself is used differently by different writers. For example, Dr. Stockman<sup>3</sup> maintains that pernicious anaemia is

<sup>1</sup> Spencer, Erasmus Wilson Lecture. *Lancet*, Vol. 1., 1897.    <sup>2</sup> *Ibid.*

Stockman, *Brit. Med. Jour.*, Vol. 1., 1895.

not in itself a disease but rather an extreme degree of anaemia following on internal capillary haemorrhages. Dr. William Hunter,<sup>1</sup> on the other hand, holds that it is a distinct pathological condition in which none of the ordinary causes of anaemia are to be found and in which the post-mortem appearances are more or less distinctive. With the one, the anaemias for which no visible cause can be found have the same pathology as those resulting from considerable haemorrhages; with the other, the two are quite separate conditions. There are, however, many cases on record which would not seem to include themselves in either of these definitions, or possibly to occupy a position midway between them. Clinically, they present all the features of pernicious anaemia; and while an haemorrhage may seem to be their starting-point, the amount of blood lost, being temporary or small in amount, seems quite inadequate to explain such profound and progressive anaemia. The post-mortem examinations, too, give confirmation to this view, that in some of these cases at least the anaemia is not due to the haemorrhages.

It is with these various considerations before us that I have collected together and examined the tissues of fifteen cases, in which, during life, anaemia was a prominent symptom. The cases were very different. In some the anaemia seemed undoubtedly primary, in others it accompanied other well-defined diseases.

It is by comparing the tissues in this variety of cases, regarding them in the light of their clinical histories, that I propose to pursue the inquiry into the pathology of pernicious anaemia.

For permission and encouragement to publish these cases I am indebted to Dr. Lindsay Steven, a former pathologist, and to Dr. Workman, the present pathologist to the Royal Infirmary. The notes of the clinical histories and of the post-mortem macroscopic appearances are taken from the post-mortem room journal. I myself am responsible for the microscopic examination of the tissues.

*Case 1.* Mrs. M., *aet.* 31. Died May 21, 1896. A case of profound anaemia, commencing with signs of dyspepsia and

<sup>1</sup> Hunter, *Lancet*, Vol. II., 1888.

being characterized by increasing weakness, pallor, oedema of the feet, shortness of breath. Duration of whole illness about five months. Evidence of cardiac failure, of fluid in both pleural cavities, of albumin in the urine. Haemorrhages in the fundi of both eyes. Blood "very pale," red corpuscles 15 per cent., no excess of white corpuscles.

*Post-mortem examination.*—Pericardium and pleurae contained a large quantity of clear serum. Heart (10½ ozs.) pale and soft, valves normal, no evidence of fatty degeneration on microscopic examination; small haemorrhages in the substance and on the surface of heart-muscle. Lungs slightly oedematous, otherwise healthy. Liver (52 ozs.) presented appearances of passive hyperaemia and fatty degeneration; microscopically, fatty changes found chiefly at centres of lobules. Spleen normal in size and structure. Kidneys showed signs of commencing interstitial nephritis; considerable congestion in the capillaries. Stomach dilated, its mucous membrane pale and in places atrophied. Intestines showed patches of congestion and in places small haemorrhages. Marrow from femur deep red in colour and semi-fluid in consistence. Microscopic examination of marrow showed no trace of fat cells, these being completely replaced by blood corpuscles of various kinds and sizes. These corpuscles presented no very definite arrangement and consisted of (*a*) leucocytes with single oval nuclei and clear plasma (marrow cells). In some cases the plasma contained coarse oxyphile granules, giving the corpuscles the appearance of the eosinophile corpuscle normally found in the blood. (*b*) Large numbers of nucleated red blood corpuscles, ranging in size from that of an ordinary red disc to the very large corpuscles (giant cells) which often contained several red blood corpuscles in their interiors. Nuclei usually single; sometimes two, sometimes three in number. Some corpuscles contained coarse granules, making them look like eosinophile cells; if they were such, they were nucleated red blood corpuscle eosinophile cells, and not eosinophile cells of the leucocyte class. (*c*) Large numbers of red blood corpuscles. (*d*) Lymphocytes (small mononucleated leucocytes), sometimes solitary, sometimes collected into small groups.

Sections from various organs were treated with potassium



ferrocyanide and hydrochloric acid, so as to demonstrate any deposit of iron pigment that might exist. In the liver this deposit was considerable, both in the capillaries and in the liver cells. In the capillaries it appeared as small dark blue masses and in the hepatic cells in a much finer state of division. This pigment was most abundant in the cells at the outer parts of the lobules. In the spleen only a very few cells contained pigment, and the same applied to the epithelium of the kidneys. In the bone marrow there was a moderate deposit of iron, but it was impossible to state in what cells it was contained.

*Case 2.* Mrs. S., *aet.* 30. Died Feb. 2, 1895. A history of gradually increasing weakness, pallor, emaciation, vomiting, diarrhoea. Duration of illness about one year. Urine contained a trace of albumin. Blood, (*a*) a month before death—red corpuscles 30 per cent., haemoglobin 35 per cent.; (*b*) a day before death—red corpuscles 16·3 per cent., haemoglobin 17 per cent.

*Post-mortem examination.*—Pericardium contained  $3\frac{1}{2}$  ozs. clear serum. Heart ( $11\frac{1}{2}$  ozs.) had no external fat, muscle presented no appearance of fatty degeneration. Lungs, emphysematous and oedematous. Liver (49 ozs.) presented no fatty change. Spleen ( $3\frac{3}{4}$  ozs.) normal. Left kidney markedly cirrhotic, right kidney showed commencing cirrhosis. Supra-renal capsules normal. Mesenteric glands slightly enlarged. No specimen of bone marrow.

Deposit of iron pigment in the liver cells was very marked. Present also to a slight degree in the capillaries. No iron pigment in the other organs.

*Case 3.*<sup>1</sup> M. T., *aet.* 52. Died May 7, 1892. Symptoms were progressive weakness, pallor, palpitation, breathlessness, oedema of feet, frequent attacks of vomiting. No albumin in urine, no history of haemorrhages. Duration of illness about two years. Red corpuscles 10 per cent., haemoglobin “showed a marked reduction.”

*Post-mortem examination.*—Heart (16 ozs.) healthy except for a pretty considerable fatty degeneration of its muscle fibre.

<sup>1</sup> This case was reported by Dr. Gemmell and Dr. Steven at a meeting of the Glasgow Pathological and Clinical Society, May 9, 1892. (*See Glas. Med. Jour.*, October, 1892.)

Liver (75 ozs.) slightly enlarged, fatty degeneration of hepatic cells at centres of lobules. Spleen ( $6\frac{1}{2}$  ozs.) soft, deep red in colour. Kidneys normal. Lungs oedematous. Ventricles of brain distended with fluid. Marrow of femur red in colour, semi-fluid in consistence.

Marked deposit of iron pigment in liver cells; deposit in capillaries slight. Practically no deposit in other organs.

*Case 4.* J. R., *aet.* 19. Died August 26, 1896. Case of profound anaemia with symptoms of headache, giddiness, breathlessness, pallor, prostration, constipation. Duration of illness about eight weeks: it seemed to start from an attack of acute tonsillitis. History of chronic purulent discharge from one ear. Blood corpuscles 21 per cent.; haemoglobin 18 per cent. No relative excess of white corpuscles.

*Post-mortem examination.*—Heart (14 ozs.) enlarged, pale, with appearances of fatty degeneration. Liver (45 ozs.) showed moderate fatty degeneration. Spleen (4 ozs.), kidneys, suprarenals, stomach and intestine practically normal. The marrow in the femur was red in colour and microscopically the same kinds of corpuscles as described in case 1 were seen. Here, however, the fat cells were considerably more in evidence, they not yet having been displaced by the invading corpuscles. There was also a fairly large proportion of marrow cells; but what struck one most was the large number of lymphocytes collected together in places so as to form distinct groups. There were almost none of the large cells containing yellow pigment masses, met with in some of the other cases.

Liver contained a considerable deposit of iron pigment, present in the capillaries but in much greater abundance in the hepatic cells. In splenic pulp some iron pigment both in the white corpuscles and in the spaces between them; none in kidneys or suprarenals.

*Case 5.* C. G., *aet.* 29. Died December 24, 1894. Illness had a duration of five months. It dated from a confinement during which there was a very considerable amount of haemorrhage. Symptoms were progressive weakness, pallor, oedema, vomiting, giddiness. Red corpuscles 20 per cent., they presented great irregularity in shape, microcytes were present; haemoglobin 21 per cent.

*Post-mortem examination.*—Pericardium and left pleural cavity each contained several ounces of clear serum. Heart ( $12\frac{3}{4}$  ozs.) increased in size and external fat much greater than normal; muscle wall soft and pale and the seat of extensive fatty degeneration; valves and coronary arteries healthy. Lungs oedematous. Liver (70 ozs.) enlarged, with marked fatty degeneration especially at centres of lobules. Spleen ( $6\frac{1}{2}$  ozs.) soft, deep red in colour, malpighian corpuscles larger than normal. In intestine the solitary follicles near to ileo-colic valve unduly prominent. Glands of stomach slightly atrophied, with slight increase of the connective tissue round about them. Kidneys, suprarenals and pancreas all healthy. Marrow of femur reddish in colour and semi-fluid in consistence; appearances microscopically similar to those in case 1. Here, however, there was possibly a slightly larger proportion of marrow cells.

Deposit of iron pigment in liver considerable; more marked in hepatic cells than in capillaries. No deposit in any other organs.

*Case 6.* Mrs. F., *aet.* 31. Died March 18, 1897. Case of profound anaemia of several months' duration. History of increasing weakness, pallor, emaciation, dating from a confinement during which patient lost a considerable quantity of blood. On several occasions during the illness there were haemorrhages from the bowels. Blood examined a week before death—red corpuscles 16 per cent., haemoglobin 15 per cent., white corpuscles 1 in 44.

*Post-mortem examination.*—Pericardium contained 3 ounces of clear serum. Heart (9 ozs.) soft and flaccid; its muscle presented appearances of fatty degeneration. Liver (61 ozs.) pale and soft; fatty degeneration in many of the hepatic cells, especially those at centres of lobules. Spleen ( $8\frac{1}{2}$  ozs.) considerably enlarged; pulp packed with blood corpuscles. Mesenteric glands enlarged, soft and pale, but structurally quite normal. Kidneys, suprarenals, pancreas, stomach and intestines presented normal appearances. Marrow from femur salmon-coloured and semi-fluid; microscopic appearances similar to those of case 5.

Deposit of iron pigment in liver very slight, less marked in

hepatic cells than in the capillaries. No pigment to be seen in other organs.

*Case 7.* A. M., *act.* 41. Died Dec. 28, 1896. Case characterized by progressive weakness, breathlessness, palpitation, oedema of feet and legs, pallor of skin and mucous membranes—all of about twelve months' duration. Enlargement of cardiac, hepatic and splenic areas; evidence of mitral incompetence, trace of albumin in the urine, haemorrhages into fundi oculorum. Three months before onset of illness a severe attack of diarrhoea, with blood in the motions, lasting for three weeks. For a time great improvement under treatment, as seen by examinations of the blood:

- (a) Five months after onset of illness, red corpuscles 21 per cent., haemoglobin 18 per cent.
- (b) Three months later, red corpuscles 65 per cent., haemoglobin 70 per cent.
- (c) Three months later still, red corpuscles 27 per cent., haemoglobin 25 per cent.
- (d) A week before death, red corpuscles 16 per cent., haemoglobin 12 per cent.

*Post-mortem examination*—Heart (17 ozs.) enlarged, with sub-pericardial fat slightly in excess. Both ventricles dilated and left somewhat hypertrophied. Muscle tissue pale and soft, the seat of considerable fatty degeneration. Mitral valve had some vegetations along the edges of its curtains. Lungs oedematous and bronchial mucous membranes congested. Liver (78 ozs.) enlarged, soft, pale, with fatty degeneration in the cells at centres of lobules. Spleen (13½ ozs.) much enlarged; structure quite normal. Kidneys, pancreas and stomach all healthy. Mucous membrane of intestines was pale, and a superficial ulcer was to be seen near to the ileo-colic valve. Bone marrow from one of the ribs bright red in colour.

Liver showed but slight deposit of iron pigment, and that almost entirely confined to the capillaries. Kidneys had a very slight iron deposit in their convoluted tubules. Other organs were free from this pigment.

*Case 8.* T. R., *act.* 60. Died Dec. 14, 1893. Symptoms were progressive weakness, pallor, drowsiness. Oedema of feet



and signs of fluid in both pleural cavities. Patient had suffered for twenty-six years from bleeding piles. Blood examined three weeks before death—red corpuscles 23 per cent., haemoglobin 25 per cent.

*Post-mortem examination.*—Considerable serous effusion into pericardium, both pleural cavities and into abdominal cavity. Heart ( $16\frac{1}{2}$  ozs.) enlarged, external fat very much increased; muscular tissue pale and flabby, having undergone considerable fatty degeneration. Lungs oedematous. Liver ( $44\frac{1}{2}$  ozs.) small and pale; considerable fatty degeneration of the hepatic cells. Spleen ( $2\frac{1}{2}$  ozs.) quite normal. Kidneys, suprarenals, stomach and intestines also normal. Marrow from femur semi-fluid and red in colour; microscopic appearances similar to those described in case 5.

Deposit of iron pigment in the liver, though quite distinct, was by no means abundant. It was more marked in the capillaries than in the hepatic cells, in which it appeared more as a diffuse stain than as a finely granular deposit. In the kidneys there was a distinct deposit in the epithelium of convoluted tubules; practically none in any of the other organs.

*Case 9.* J. M., *aet.* 45. Died July 30, 1894. Case of anaemia of four years' duration, characterized by progressive weakness, pallor, breathlessness, palpitation, oedema of feet and eyelids. Trace of albumin in urine. Patient had been subject to chronic bronchitis for twenty years. Blood examined shortly before death—red corpuscles 18·6 per cent., haemoglobin 20 per cent.

*Post-mortem examination.*—Pericardium, left pleural cavity and abdominal cavity each contained several ounces of brown-coloured serum. Heart ( $10\frac{1}{2}$  ozs.) soft and flabby, external fat increased, but muscle fibres free from fatty changes. Lungs oedematous. Liver (60 ozs.) showed moderate fatty degeneration. Spleen (12 ozs.) much enlarged, soft, in structure quite normal. Both kidneys slightly enlarged, with slight increase of the connective tissue elements, suggesting a commencing interstitial nephritis. Bronchial lymphatic glands enlarged and the seats of minute extravasations of blood. Stomach showed atrophy in many of the gastric glands. Nothing special to note in pancreas, suprarenal capsules or thyroid

gland. Brain very pale, its ventricles distended with brown-coloured serum. Marrow from femur had semi-fluid consistence and bright red colour; its fat cells had been entirely displaced; there was a fair proportion of marrow cells, and otherwise the appearances were similar to those in case 6.

Liver contained a considerable deposit of iron pigment both in the capillaries and in the hepatic cells. Slight deposit in renal and intestinal epithelium as well as in the lymphatic glands.

*Case 10.* Mrs. B., *act.* 26. Died June 11, 1896. A case of cardiac failure with signs of mitral incompetence; albumin and blood in urine, considerable fluid effusions into pericardial, pleural and abdominal cavities. There was great pallor and nutrition generally was much impaired. Bleedings from gums, bowels and air passages. Small ecchymoses in the legs. The condition of blood was not noted.

*Post-mortem examination.*—Large quantities of serous fluid in pericardial, pleural and abdominal cavities. Heart (16 ozs.) dilated in both ventricles; valvular structures healthy; muscle fibres free from fatty change. Passive hyperaemia and oedema of both lungs; large areas occupied with haemorrhagic infarctions not obviously of embolic origin. Liver (4·3 ozs.) presented a marked fatty degeneration, especially in the central parts of the lobules. Spleen (6 ozs.) much congested; microscopically its pulp was seen packed full of red blood corpuscles. Kidneys showed marked hyperaemia of their vessels. Intestines hyperaemic with submucous haemorrhages. Pancreas and suprarenals normal. Marrow from femur red in colour; its fat cells in some places quite intact, in others entirely replaced by blood corpuscles; a fair proportion of marrow cells and a considerable number of very large nucleated red corpuscles (gigantoblasts) noted; the rest of the tissue consisted of red corpuscles and nucleated red blood corpuscles.

A considerable deposit of iron pigment in the liver, most marked in the hepatic cells, especially those at the external two-thirds of the lobules; no deposit in any of the other organs.

*Case 11.* A. M. Died June 5, 1896. A case where the prominent symptoms were profound weakness, pallor, occasional

attacks of diarrhoea and bleeding at the nose. A less degree of anaemia had existed for some four or five years, dating from an attack of rheumatism, since which time there had been shortness of breath and other evidence of valvular disease of the heart. Red corpuscles 20 per cent., haemoglobin 10 per cent.

*Post-mortem examination.*—Heart (16 ozs.) considerably enlarged, its muscle soft and pale, with the appearances of fatty degeneration. Numerous minute haemorrhages were found scattered throughout its substance. The mitral and tricuspid valves were thickened and deformed, evidently the result of chronic endocarditis. Minute haemorrhages found on the surface of the lungs. Liver (60 ozs.) hyperaemic, considerable fatty change in the hepatic cells. Kidneys much congested; both had appearances of commencing interstitial nephritis. Spleen (7 ozs) enlarged and dark red in colour. Numerous areas of congestion in alimentary tract; in caecum several small ulcers, each about the size of a millet seed. Considerable atrophy in the glandular epithelium of the stomach. Suprarenals and thyroid normal. Marrow from femur red in colour; microscopic appearances much the same as those in case 6.

Deposit of iron pigment in liver very slight; absent in other organs.

*Case 12.* A. Z., *act.* 57. Died Jan. 22, 1892. A case of heart disease (mitral incompetence), of at least two years' standing, following an attack of rheumatism. For some months before death signs of cardiac failure with increasing anaemia. Attacks of epistaxis frequent and a purpuric eruption was present on the legs. Red corpuscles 24 per cent., haemoglobin 22 per cent.

*Post-mortem examination.*—Subcutaneous fat abundant. Pericardium contained six ounces of clear serum. Heart (14½ ozs.) enlarged and its muscle tissue showed distinct signs of fatty degeneration. Liver (51 ozs.) pale, only slight fatty change in the hepatic cells. Spleen (4 ozs.), kidneys and suprarenal capsules were quite normal. Stomach enlarged; there was to be noted in its anterior a small ulcer which microscopic examination proved to be cancerous. Marrow from femur was a mass of yellow fat and contained none of

the corpuscular elements found in red marrow. Practically no deposit of iron pigment in any of the organs.

*Case 13.* M. F., *act.* 55. Died Nov. 11, 1893. A case of syphilitic disease of the liver associated with chronic bronchitis and obstinate constipation, of some months' duration. Pallor of skin and mucous membranes very pronounced; considerable oedema of subcutaneous tissues. Red corpuscles 54 per cent., haemoglobin 17 per cent.

*Post-mortem examination.*—Abdominal wall contained a layer of fat two inches thick; peritoneum, mesentery and omentum likewise loaded with fat. Heart (13 ozs.) pale, but it showed no fatty changes. Liver (75 ozs.) considerably enlarged and on section seen to be studded with white nodules varying in size from that of a hazel nut to that of a split pea. Microscopic examination showed these to consist of inflammatory cells displacing and destroying considerable areas of hepatic tissue: the appearances strongly suggested syphilitic disease of the liver; fatty degeneration was noted in many of the remaining liver cells. Spleen ( $13\frac{1}{2}$  ozs.) enlarged; it contained some nodules similar to those in the liver. Kidneys, stomach and intestines healthy. Marrow from femur semi-fluid and red in colour.

Amount of iron pigment in liver very slight; it was present in the capillaries as much as in the liver cells.

*Case 14.* J. B., *act.* 35. Died Oct. 6, 1896. A typical case of Addison's disease of twelve months' duration. Red corpuscles 88 per cent., haemoglobin 70 per cent., slight increase in number of white corpuscles.

*Post-mortem examination.*—Some old tuberculous disease at apices of both lungs. Suprarenal capsules almost completely replaced by caseating tuberculous masses. Some of the abdominal glands also caseous. Heart (7 ozs.), liver (44 ozs.), spleen ( $7\frac{1}{2}$  ozs.), stomach, intestines and kidneys all much congested but structurally normal. Marrow from femur slightly red in colour and microscopic examination confirmed the suggestion of a commencing "lymphoid" change. In places the fat cells were found quite intact, but in other parts of the sections these were becoming replaced by red corpuscles and nucleated red corpuscles. Not many marrow cells were in evidence, but there



were to be noted some much larger cells which contained opaque yellow masses. Whether these last were nucleated red corpuscles or marrow cells much enlarged, it was difficult to say.

The spleen was the only organ with a deposit of iron pigment, but in it the amount was very considerable. The pigment granules were seen in the white corpuscles of the pulp as well as in large masses lying outside of these cells.

*Case 15.* Mrs. D., *æt* 34. Died March 9, 1897. A case of Hodgkin's disease of some two months' duration. There was enlargement of glands in the neck, armpits and groins; spleen and liver were likewise enlarged. There was albumin and blood in the urine, oedema at the ankles, bleeding at the nose and purpuric patches on the thighs. Red corpuscles 72 per cent., haemoglobin 50 per cent., white corpuscles 1 in 33.

*Post-mortem examination.*—Heart (12 ozs.) soft and pale, but otherwise normal. Lungs oedematous. Liver (109 ozs.) greatly enlarged; with the microscope it was seen to be infiltrated throughout with lymphoid cells, which, in places, especially round the vessels, were collected in such masses as to entirely replace the hepatic cells. Kidneys both enlarged; they also presented considerable infiltration with lymphoid cells. Spleen (36 ozs.) greatly enlarged and of a salmon colour. The pulp was full of cells like ordinary white blood corpuscles; malpighian bodies not increased in size. Lymphatic glands all over the body enlarged but structurally quite normal. Pancreas slightly infiltrated with lymphocytes. Suprarenal capsules, stomach and intestines normal. Marrow from femur was salmon-coloured; unfortunately there was no opportunity to examine it microscopically. No deposit of iron pigment in any of the organs.

We have, then, presented to us in these fifteen cases a variety of anaemias, and the difficulty which remains is their classification. It is with this before us that we now proceed to consider the meanings of the various morbid changes just recorded; and as the deposit of iron in the liver has specially attracted attention, we shall consider it first.

We have already seen how an excessive destruction of red corpuscles in the portal circulation produces a deposit of iron pigment in the liver cells. And we know that a precisely similar condition of the liver is recognized as being the characteristic, and possibly the only, constant morbid change met with in pernicious anaemia. It seems, therefore, quite reasonable to conclude—especially in absence of definite proof to the contrary—that pernicious anaemia is likewise due to excessive destruction of blood in the portal area. That this iron in the hepatic cells is not derived from internal haemorrhages is pretty certain; for the iron from extravasated blood is carried to the spleen rather than to the liver, and if any of it does appear in the liver it is as small masses in the capillaries and not as fine granules in the hepatic cells.<sup>1</sup>

A marked deposit of iron in the hepatic cells, then, indicates an excessive destruction of red corpuscles, by some poison passing into the portal circulation from the alimentary tract. According to this view the pathology of our first three cases is quite clear: in each of them there was the large amount of iron in the liver cells and in each there was no visible cause for the anaemia. They are what we might call unequivocal cases of pernicious anaemia.

The six next cases, however, are not so easily classified; for, while corresponding to the above in their symptoms and physical signs, they differ, either in the post-mortem appearances or in their having a history of some possible "cause" for the anaemia. Thus, cases 4, 5 and 9 resemble our first three cases in there being in all of them a very considerable deposit of iron in the hepatic cells. But in case 4 there was the history of an acute tonsillitis as the starting-point of the illness, in case 9 there had been chronic bronchitis for twenty years, while in case 5 the anaemia dated from an haemorrhage during childbirth. But, again, iron pigment in the liver cells means destruction of red corpuscles in the portal circulation, therefore these three cases must also have had this destruction of blood in their portal circulation. The tonsillitis, then, of case 4, the bronchitis of case 9, and the haemorrhage of case 5 must be regarded, not as the causes of these anaemias, but

<sup>1</sup>Hunter, *Lancet*, 1892.

simply as producing a debility favourable to the production in the alimentary tract of certain poisons; and it is to these poisons that we must consider the anaemia to be due. We might have discounted as "accidental" the "causes" in cases 4 and 9, and called them cases of pernicious anaemia; but this could not be so in case 5, which seemed so directly dependent on a profuse haemorrhage. Case 5 is just the kind of case that has been denied the name "pernicious," and so I quote it to show that an anaemia may be a pernicious anaemia in spite of having had a history of haemorrhage.

The other three cases in this group, numbers 6, 7 and 8, resemble case 5 in also having a history of some loss of blood; but in none of the three was there much iron pigment in the liver cells. The anaemia in these cases, then, must in the meantime be looked upon as due to haemorrhage. It is to be noted, however, that the hepatic cells in none of them were quite free from iron pigment. In case 8, indeed, the pigment was fairly well marked, and, although not nearly so abundant as in case 5, there was quite sufficient to suggest some relationship between the two. We have no explanation here, however, as to why, in some cases, a haemorrhage is the starting-point of a rapidly increasing anaemia—which is not "pernicious"—while in others an equal loss of blood produces little or no effect.

The six cases still remaining seemed undoubtedly to be secondary anaemias. Cases 10, 11 and 12 were cases of heart disease; but while 11 and 12 had practically no iron pigment in the liver, in case 10 the deposit was as considerable as in case 1. During life there was no thought of case 10 being a primary anaemia, as may be concluded from the fact that the corpuscles in the blood were not enumerated. The congested condition of the organs, too, and the haemorrhages all correspond to the diagnosis of cardiac failure. But then the large deposit of iron in the liver cells means an excessive destruction of blood in the portal circulation; and so case 10 must be considered a case of heart disease in which pernicious anaemia appeared as a complication. In the last three cases—cases 13, 14 and 15—there was no iron pigment in the liver cells.

We have seen, then, that the anaemia of the first five cases

and of cases 9 and 10, is due to an excessive destruction of blood in the portal area, and in cases 6, 7 and 8—as far as we at present understand—to direct loss of blood through single or repeated haemorrhages. But in the five cases still remaining we must find another explanation, for in none of them was there any appreciable deposit of iron in the hepatic cells, and in none a history of haemorrhage. The cause of their anaemia must then have been due either to defective formation of blood or else to an increased destruction of blood brought about in a manner different from that caused by such a poison as toluylendiamin. In case 11, where the marrow of the femur was unaltered, the anaemia might have been due to defective formation of blood; but in the other four cases the change of the yellow marrow to red (which means an increased formation of red corpuscles) favours rather the view of an increased destruction of blood. It is quite readily understood why in certain diseases there should be this increased destruction of red blood corpuscles. In heart disease the circulation is defective and there is an increase of waste product poisons in the blood. Addison's disease and syphilis are in all probability also due to a poison; and it must likewise be some poison which causes the overgrowth of the spleen and lymphatic glands in Hodgkin's disease. These poisons in the blood must have an injurious effect on the nutrition of the red corpuscles, and we have already seen that unhealthy red blood corpuscles are soon removed from the circulation and destroyed. But this process of blood destruction is of a totally different nature from that in the cases of pernicious anaemia. It applies more or less to the whole circulation, it is slow and chronic, and indeed just a part of the general tissue destruction which takes place in most wasting diseases. In blood destruction of this kind there is no increased deposit of iron in the liver cells.

The deposit of iron pigment in the other organs was but slight. When found in the renal epithelium in cases of pernicious anaemia, it is explained as being an excess of pigment, which, passing through the liver, reaches the general circulation, and is in the process of being excreted by the kidneys.<sup>1</sup> The pigment in the renal epithelium of all our cases was

<sup>1</sup> Hunter, *Lancet*, 1892.



variable and small in amount, and we need give it no special consideration.

Before leaving the subject of the deposit of iron in the tissues, I wish to note that the method of its demonstration by ferrocyanide of potassium and hydrochloric acid is somewhat uncertain and liable to lead to error. I frequently found that sections from different parts, and sometimes from the same parts of a liver, did not show the iron reaction equally well, and I had to examine many sections in a case to be certain as to a negative result. The reaction under ordinary circumstances does not take place when the iron is intimately combined with the protoplasm of the cells, as for example in the red blood corpuscles and in the tissues generally. But in some of my sections I found the nuclei of the hepatic and renal epithelial cells stained a light blue colour, due doubtless to the iron of these nuclei giving the reaction. This was probably caused by the use of too strong reagents. I feel sure, however, that my positive results were not due to a reaction from iron in chemical combination in the cell protoplasm, for then the deposit would not have appeared granular and it would not have limited itself to the cells at the outer parts of the lobules. In the cells whose nuclei turned blue the appearance was not that of a granular deposit but rather of a diffuse stain, and there was no appearance of any iron reaction in the plasma of the cells.

As regards the relationship between the amount of iron in the liver and the deficiency of haemoglobin and red blood corpuscles in these cases, one cannot draw any definite conclusion. In the first nine cases—those we might call the primary anaemias—one is struck by the very slight difference between the percentages of haemoglobin and of red corpuscles. The difference in none of the cases is greater than might be accounted for by the methods of estimation. In none of the cases with iron in the liver cells was there the great excess of haemoglobin over corpuscles said to be found in cases of pernicious anaemia; and in none of the cases following haemorrhage was the deficiency of haemoglobin much greater than that of the red blood corpuscles. But why in cases of pernicious anaemia should there be an excess of red colouring

matter in the general circulation when, according to the pathology we have been considering, this excess is confined to the portal circulation? We have seen that before the blood reaches the general circulation most of the free pigment is absorbed by the hepatic cells, and in our cases this seemed to be so, judging from the proportion of haemoglobin in the blood and the amount of iron pigment in the renal epithelium. Further, if we accept the view advanced by Hunter,<sup>1</sup> that the microcytes found in the blood in pernicious anaemia are products of blood destruction and not stages in the evolution of the red blood corpuscles—if we take this view, we should expect the microcytes likewise to be confined chiefly to the portal circulation. This corresponds with my own observations, which go to show that microcytes are not nearly so often found in the blood as some would have us believe.

Comparing these first nine cases—the primary, with the last five—the secondary anaemias, we find that in the latter the normal proportion of haemoglobin to red blood corpuscles no longer exists, but that the haemoglobin, in almost all the five cases, falls considerably short of the corpuscles. This state of matters accords with the view that a deficiency of red corpuscles is much more easily made good than a deficiency in haemoglobin.

The proportion of the white blood corpuscles present in the blood has been noted in so few of the cases, that we can draw no conclusions.

The other changes found in the general tissues as a result of anaemia were due chiefly to the defective blood supply. Fatty degeneration of the heart-muscle and liver-cells were the two most constant phenomena; and although these appearances were not found in all the cases, they were present in a very considerable proportion. There seems nothing to show why there should be this fatty change in some of the cases and not in others. I suppose we must fall back on the idea of a “pre-disposition” in the cases most affected.

We saw that in some of the cases there was atrophy of the gastric epithelium. This probably was also due to a defective blood supply, and the appearances suggested this rather than a destruction of the epithelial cells by an inflammatory process.

<sup>1</sup> Hunter, *Lancet*, 1892.

In four of the cases there was interstitial nephritis in greater or less degree. This nephritis may have been "accidental" or possibly due to the poison concerned in the production of the anaemia.

Of the changes in the tissues which are more intimately associated with blood formation, the most striking are those in the bone marrow. In case 2 the marrow was not examined and in case 7 only the marrow of the rib was seen; but in all the others, except case 12, the marrow of the femur showed, in a greater or less degree, the appearances of red marrow. In nearly all the cases this transformation of the yellow marrow into red was very complete, and the only cases in which any considerable number of fat cells persisted were cases 4, 10 and 14. This change in the marrow, however, is evidently not in direct proportion to the degree of anaemia. In case 14, where there was but little deficiency in the blood elements (red corpuscles 88 per cent., haemoglobin 70 per cent.), the fat spaces of the marrow were invaded to a very considerable extent by the red marrow cells. In case 12, on the other hand, where the anaemia was very pronounced (red corpuscles 24 per cent., haemoglobin 22 per cent.), there was no appearance of any such change. This surely means that in some cases the response to the demand for an increased supply of red corpuscles is much more ready than in others. Failure in blood formation would not then seem to be a frequent cause of anaemia. It may, however, be that treatment stimulates the bone marrow to a special activity and that this accounts for the temporary improvement, under treatment, in some cases of pernicious anaemia. When this activity is exhausted then the disease will rapidly get worse.

In considering the condition of the spleen in these fifteen cases we do not learn much, and it is very difficult to know what exactly determines its varying size. We say that poisons stimulate the leucocytes to multiply and that the spleen has to increase to produce them, or to store them. Theoretically, in pernicious anaemia, we should expect the spleen to be large; but this is not the case in the majority of our cases, and Hunter's<sup>1</sup> idea of the paroxysmal destruction of red blood

<sup>1</sup> Hunter, *Lancet*, 1892.

corpuscles is not a very convincing explanation of the small spleen so often found in this disease. Is it not more probable that while the poison of pernicious anaemia stimulates the white blood corpuscles to increase, it itself destroys the red corpuscles? It must surely at least affect their vitality, for otherwise no moderate leucocytosis would destroy them. In some of our cases enlarged lymphatic glands were found, but this has little bearing on the pathology of pernicious anaemia.

I have been endeavouring, then, in the foregoing pages, to point out that there is a certain relationship between all pro-found anaemias. They would seem to differ less in their physical signs than in their etiology, and it is the etiology which largely determines their pathological anatomy. Most of them are due in some measure to an excessive destruction of red blood corpuscles, and this in turn depends for its production and maintenance on a poison in some part of the circulation. The origin and nature of this poison have not yet been clearly defined, but we have seen that it differs in several respects in the different groups of cases. One of these groups is associated with, and probably the result of, certain wasting diseases, and its poison, which is in the general circulation, is slow and constant in its action. None of the iron liberated from the red blood corpuscles destroyed is deposited in the liver cells. In another group the poison seems to be absorbed from the alimentary tract and to be confined in its action to the portal circulation. In destroying the red corpuscles it liberates an iron pigment which is taken up by the hepatic cells, any small amount reaching the general circulation being deposited in the renal epithelium. There is yet a third group, in which, in physical aspect, the cases resemble very closely those last mentioned. They differ, however, in seeming to depend for their production on single or repeated haemorrhages and also in having little iron in the liver cells. The anaemia in some of these is doubtless due to the amount of blood lost; but in others, where a rapidly progressive anaemia follows one single haemorrhage, this explanation seems inadequate. It may be that certain cases have the capacity of recovery from an haemorrhage, while in others the efforts of the organism



altogether fail to make up the blood lost. It may be that, in these efforts of the organism at recovery, there lies the possibility of an increasing anaemia, for we have seen that following haemorrhage new blood corpuscles are sent into the circulation immature, and as such they readily succumb. If this goes on to any extent the anaemia will thereby be increased rather than diminished, for the products of corpuscle disintegration, in their turn, will act as a poison to other blood corpuscles.

The term "pernicious," then, as applied to anaemias is unsuitable. If we apply it only to those cases with an excess of iron in the liver cells, the term will be of no use clinically; for we have seen that of cases almost exactly similar (cases 5, 6, 7 and 8), one had abundant iron in the liver, while some of the others had practically none at all. If, on the other hand, we apply the term to the cases that are "progressive" it is equally unsuitable and indefinite. The classification of the anaemias is doubtless difficult, but in the meantime it would seem better to classify them as "primary"—those with their own "cause," and "secondary"—those which occur in the course of another well-defined disease. Even then some cases will be found having the features of both classes, and some, while starting in one class will pass into the other.

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